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ABSTRACT

This manual contains nine modules on the metric system: background and overview, length and basic prefixes, volume, mass, temperature, relationships within metric system, everyday applications, relationships between metric and English, and developing a teaching plan. Each module states objectives, suggested activities, and illustration of mastery. Modules provide a variety of learning patterns: independent study, individual with instructor, small group work, and large group work. A variety of games and puzzles, pretests, posttests, and answer keys are contained in the manual in addition to a list of references and sources. (JW)

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SE 020 415

A TEACHER'S WORKSHOP MANUAL FOR INDIVIDUALIZED INSTRUCTION

BY

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OVERVIEW OF THE MANUAL

This manual has been developed to help acquaint elementary teachers with the metric system of measurement. The content of metric measurement has been divided into "modules" with each module covering a given metric subject. For example, one module deals with metric length, another volume, another mass and so on. Content is arranged so there are no metric-English conversions until basic aspects of metric measurement have been discussed. If desired, metric-English conversions (Module 8) may be omitted. Activities for elementary students are presented in Appendix A.

Each module has three divisions--(1) objectives; (2) suggested activities to meet the objectives; and (3) illustration of mastery. These modules were developed in the same format that has been used successfully in the graduate courses in IGE at the University of Wisconsin-Eau Claire. The objectives and subsequently the activities and illustration of mastery range from the behavioral-type for learning content to the expressive-type for developing a game or materials. This allows for a creative and humanistic approach to learning the metric measuring system as well as gaining a knowledge of the subject matter. This approach parallels Bloom's hierarchy of cognitive levels.

The modules also allow for teachers to learn at their own rate and style and to enter the learning process according to what they already know about metric measurement. There is also provision in the modules for a variety of learning patterns--independent study, one-to-one with instructor or another adult, small group, and large group. In the culminating module, number 9, the teacher develops a plan for teaching metric measurement to the age/grade level or children that he/she is working with in his/her own school. The teacher may adapt any materials or ideas from this manual including assessments, games and worksheets for his/her students. In addition, the teacher will key in text, and/or audiovisual and manipulative materials available in his/her building/system.

It should be remembered that this manual, in the spirit of IGE, will never be "finished." New materials on metric will continually come to the attention of an alert teacher and, of course, new materials will constantly be produced. Teachers will be encouraged to develop resource files for use with their students. Assessments and their accompanying keys, readings, summary sheets and worksheets are given here in their entirety. In the case of games and laboratory activities, answers, directions and ideas are presented in the manual in so far as possible. However, in several activities, items in the room are measured and measurements will vary. For some games, only one card is presented along with suggestions for how to design the other cards.

Finally, it is the intent of the authors that this manual will be only a starting point for teachers to learn metric measurement and that it will inspire them to start a program for teaching metric to their students in an individualized and exciting manner and that they will update through the years.

J. S. S.

Eau Claire, Wisconsin
January, 1976

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METRIC COURSE SYLLABUS

General Objectives

The participants will gain an understanding of the metric system in terms of (1) basic units of measurement for length, volume, weight; (2) application of basic units to daily living; and (3) development of a plan for teaching the metric system to students at the age/grade level at which they teach.

Content will be presented from simple to complex. The instructional format will be modules which allow participants to learn according to what they already know, how rapidly they learn and how they go about learning. The modules utilize a variety of grouping patterns as large group, small group, one-to-one and independent study, and are designed to accommodate a variety of learning styles.

Content has been divided into two groups:

Group A. These modules are required for all participants:

1. background and overview of the metric system
2. metric length and basic prefixes
3. metric volume
4. metric mass (weight)
5. metric temperature
6. relationships within the metric system
7. everyday application of metric measurement
8. relationships between metric and English measurement systems

Group B. This module is required and can be carried out alone or with others. It will be started during the workshop and completed after the participant has returned to his/her school (e.g. one month after the close of the workshop). Activities in this module should utilize materials available in the participant's building/system and ideas of fellow staff members.

9. developing a plan for teaching the metric system

Objectives

The participant will be able to:

1. describe reasons for standard measurement.
2. describe briefly the history of the English and metric systems including the rationale and origin of their development.
3. indicate the basic metric units of measurement for length, volume, and mass (weight).

Suggested Activities to Meet Objectives

1. Read "Why Do We Need to Measure?" (written for children)
2. Read "How We Got Our Measuring Units."
3. Participate in laboratory discussion activity, "Concepts: Measurement and Metric."
4. Read puppet show script, "Metric in Mouseland."

Illustration of Mastery

1. Agreement of "satisfactory" between instructor and participant on completion of laboratory discussion activity, "Concepts: Measurement and Metric."
2. Completion of "Overview of the Metric System" posttest with 80 percent accuracy.

WHY DO WE NEED TO MEASURE?

The question of "how many" comes up very early in life. You learned to hold up four fingers to show that you were four years old when somebody asked you your age. It wasn't too difficult to use the idea of "how many" to count the number of children in the group, books in your desk, puppies in the garage, or marbles in a bag.

Soon you learned to count up to high numbers, and counting worked well for anything. Five dogs, five oranges, five men, five houses are all numbers that we can agree upon even though each group of articles we count is very different from the others.

But after while you found other things that couldn't be counted. Can you say how many grains of sugar in a bag, or how many lumps of coal in a bin? You probably could count a very small quantity of sugar or coal, but you usually ask "how much" for these things. When you want to know how tall a tree is or how far it is to the next town, you have to answer the question "how much".

To do this, we go back to our old question of "how many", which is usually easy to answer - but how many "what's" in the size of a tree, the road to the next city, or a pail filled with water?

How can you tell me how tall a young tree in your front yard is? You can say it is smaller than the other trees and that it is taller than you are. This tells me something, but unless I can see you and see the other tree, I don't really know the size of this tree, do I?

Suppose your grandmother in California wants to knit a pair of socks and a pair of mittens for you, but she hasn't seen you for a long time and she really isn't sure how big the socks need to be and how much yarn she needs to buy. How could you give her the information she needs? You might trace out your hand on a piece of paper and send the paper to her. Or you might send her one of your socks that fits you.

This will work without much trouble for socks or mittens, but it becomes much more difficult when someone wants to buy you a pair of skis, which should be taller than you are. Sending a pattern of your full size is not a very good way to do it. And, of course, we don't do it this way today.

Instead we have measurements which we make with various measuring instruments. Your mother can stretch a tape measure around your hand and from your wrist to your finger tips and write down the numbers she needs off the measuring tape. A month later your knitted socks and mittens arrive in the mail and they fit perfectly.

This is not magic, nor is it just good luck. The socks fit because they were measured with what we call a standard measurement, in this case a ruler that is 12 inches long. In any different city or even any foreign country this ruler is always the same size, though it may be made of plastic, wood or metal.

D. Sorenson

If I use this unit for measuring and send the figures to somebody to use, I am really doing the same thing as sending a pattern of the size socks I want. The measurements are a language that I can use to tell other people "how much" and we will both understand what we mean, even though we may never speak nor see each other.

The language of measurement is highly developed so we can say how much a container holds, how far away a star is, how much a material weighs, how fast a motor runs.

The terms we use to describe what we measure can be almost anything. In different parts of the world they may be different, but they must be accurate, they must be convenient, and they must be practical. By that we mean that every ruler must be exactly the same length wherever you may use it. You don't find rulers made out of rubber because they can be stretched to different lengths. They are metal or wood, which keeps its length.

To be convenient and practical, the measuring instrument should be something you can handle easily. A ruler short enough to carry in your pocket is good for measuring the top of your desk, but it is much handier to measure the length of your house with a long measuring tape that winds up on a reel small enough to place in your pocket.

Measuring terms may be familiar, or they may sound strange to you. It doesn't matter what they are called as long as they are convenient and accurate. Most of our measurements are accurate after long years of use and improvement, but some are not as convenient as others. They developed as they were needed and have been accepted as the language of business, science and everyday living.

As soon as people started to trade with each other, they had to know how much of a material they were buying and how much it would cost.

They needed to measure it so the customer would always get a correct amount and pay a fair price. The measuring units had to be something convenient - the length of a man's arm, the spread of his fingers, or the amount of weight that he could lift. The early tradesmen picked something convenient, and then the government usually declared it to be an exact size. Let's look at length, one of the first measures that man needed.

How the English System of Measure Started

The Foot and the Yard. It was common many years ago to measure length from the end of your nose to the fingertips of your outstretched arm. This, of course, was a short measurement for a boy and a long measurement for a grown man. It had to be definite. So the king declared that the length of his own arm would be the legal measure of length. He cut a wooden stick this long, which he called a "gyrd", the English word for rod. From this word came our word "yard", which is still the length of the king's arm.

Measuring on the ground was easier to do with your foot than with your arm. This measure was called a "foot' and the king decreed that the length of his foot would be the standard for all measurement in feet. It happened that the king's arm was three times as long as his foot, so the first yard was divided into three feet.

To measure distances smaller than a foot, you had to guess again. To get more accuracy, traders divided the foot into 12 parts and called each part an inch from the word "ynce", which meant a twelfth part. They could have divided it into 10 parts or 8 parts or even 100 parts, but 12 seemed practical since each inch was about equal to the width of a man's thumb.

The Acre, the Rod and the Mile. When farmers wanted to measure a field, they needed a more convenient measure than a yard stick or a foot rule. It was their practice to measure a field in terms of how much a man could plow with a team of oxen in one day. This was termed an "aecer", the old word for a fenced field. From it comes our word "acre".

Of course, this amount had great variation. Some farmers had slow oxen, others plowed during the long days of summer and measured a bigger acre than when they plowed in the short days of fall. They could plow only a small amount of land per day when the field was very stony, compared to a field without stones.

When engineers began to measure land for buildings and roads, they wanted an acre of more definite size. These men created a new measurement they named a "rod", about the distance between fence posts. It took 160 square rods to make an acre.

Long distances for roads and streets were measured by pacing off. The Romans measured 1,000 paces which they called a "mille", the word for 1,000. The mile is still the unit for measuring long distance in many countries, and it is often different. The old Roman mile was 1,620 yards. The English and U.S. mile is 1,760 yards. A mile measured on the water is a sea mile, which is 2,027 yards.

The Gallon and the Quart. We don't know exactly how liquid measures developed. Liquid was probably measured in a container that would hold an amount that the average man or woman could lift and carry for a distance on his shoulder or head. The wine jug became the standard for measuring liquids, and the measure was called the "galon" or "jallon", which meant a measure of capacity. For convenience in measuring smaller amounts, they divided the jug into quarters and called each one-fourth gallon a "quarter" or "quart".

The Pound and the Ounce. There were many things that couldn't be accurately measured with a yardstick or poured into a standard size bucket. How would you measure something like a cow or a sheep with just a ruler? A sheep 3 feet long is certainly not the same as a calf 3 feet long.

Animal measurement was important in trade and it required a new measuring unit called weight, which would account for the irregular sizes and shapes of different animals. The English developed a weight measure which they called a pound from the ancient word "pund", an animal enclosure. The pound was divided into 12 smaller units called ounces from the word "ynce" or "once" meaning one-twelfth part, the same division as for the foot.

The first pound that was established had 12 ounces, but later commercial traders established a bigger pound that contained 16 ounces instead of 12. The original name for an ounce was carried over to the newer pound though it no longer represented one-twelfth of a pound.

The yard and the foot, the quart and the cup, the pound and the ounce are not the measures used in most countries of the world. In many countries outside the United States, people measure with different tools and measurements. Their measuring language is called the "metric system".

How the Metric System Started

The country where it started almost 200 years ago is France. Scientists in that country thought that there should be a better measuring standard than the length of a man's arm or the amount of water he could carry on his shoulder.

The Meter, Centimeter and Millimeter. They divided the distance around the earth into many small parts. Each part they called a "meter", the word which means measurement. You probably have seen a "meter stick" and noticed it is slightly longer than a yard stick. If you could place meter sticks end to end, 10 million of them would reach from the equator to the North Pole, one-fourth of the way around the earth.

The meter stick is divided into 100 smaller pieces called centimeters, and each centimeter is about the width of a pencil. This is something like the way the American dollar is divided into 100 cents.

The Liter. The French scientists at first measured quantities of liquid in centimeters. A box 10 centimeters high, 10 centimeters wide and 10 centimeters deep would hold an amount of water they called a liter. The paper carton your milk comes in will hold about one liter, a little more than a quart. The liter is divided into smaller units called centiliters (1/100th) and milliliters (1/1000th) of a liter.

The Gram and Kilogram. The other metric measuring unit is to measure mass or weight. This unit is called the gram, which is about the weight of a paper clip. Since many things weigh much more than a paper clip, a bigger weight measurement is used called a kilogram or 1,000 grams. A kilogram is about twice as heavy as a pound.

With the three basic metric units - the meter, liter and the kilogram - we can measure everything in the metric system. It is a convenient system and is easier to work with than other systems. You will learn why as you study it in detail.

CONCEPTS: MEASUREMENT AND METRIC (Module 1)

(Laboratory Activity/ Discussion)

(This session would be led by an instructor.)

1. Why do we have standard measurements?
    a. Divide group into teams of 3-5 people and designate a team leader.
    b. Brainstorm (3-5 min.) where they used measurement today or yesterday.
    c. Each team has the assignment to measure one side of a table or other designated object (all measure same side) without any standard measuring tool(s).
    d. Team leaders present their results to total group and instructor leads discussion to point out needs for standard measurement.

2. How will the metric system affect our daily lives?
    a. Videotape (or live presentation) on general effects of metric system, how it developed, and why U. S. is changing to metric (Puppet show: Metric in Mouseland).

3. What's a Meter?
    a. Discussion leader would present a meter stick and a yard stick indicating relative length of the two.
    b. Divide group into teams of 3-5 people.
        (1) Some teams measure length of room in meters; the other teams measure in yards.
        (2) Compare results.

4. What's a Liter?
    a. Discussion leader would present liter and quart containers and indicate liter is larger than quart. Demonstrate by pouring a quart of colored water into a liter container. Discuss the difference.

5. What's a Gram?
   a. Discussion leader passes out paper clips to each person and indicates each clip weighs (masses) approximately one gram.
   b. Nickels are distributed to each participant. They are asked to estimate the mass of the nickel by comparing it with other available objects (e.g., pencils, staples, paper clips).
   c. Instructor weighs (masses) nickel to determine its actual mass.

METRIC IN MOUSELAND* (Puppet Show Script)

Teacher is Miss Millie Meter

Teacher: Good morning class. I would like to take roll call at this time. Is Waldo Yardmouse here? All right. Is Phoebe Footmouse present? Good. And is Priscilla Poundmouse here today? Good. Everyone is present today, which pleases me very much. Do you know why? Because today we are going to learn about a new way of measuring, using the metric system.

The kind of system we use now is called the English system. It was common many years ago to measure length from the end of your nose to the fingertips of your outstretched arm. But Phoebe, do you see where this is very inaccurate? The length of my arm from my nose to the tips of my fingers is a longer measurement than yours would be. So the King declared that the length of his own arm would be the legal measure of length. Thus we have what is known as the "yard."

The measure we know as "foot" was actually the length of the king's own foot. It happened that the king's arm was three times as long as his foot, so the first yard was divided into three feet. The foot was further divided into 12 parts, known as inches. One inch was about equal to the width of a man's thumb.

The wine jug became the standard for measuring liquid and the measure was called "galon", which meant a measure of capacity. For convenience in measuring smaller amounts, they divided the jug into quarters, which were called "quarts."

In many countries outside the U.S., people measure with different tools and measurements. And today, class, we are going to use this system, known as the metric system.

The country where it started almost 200 years ago is France. Scientists in that country thought that there should be a better measuring standard than the length of a man's arm or the amount of water he could carry on his shoulder.

Now Waldo, would you read the paragraph about the meter?

---

*This is a script for a puppet show. It was written by undergraduates in elementary education to provide motivation when students are starting to study the metric system. The script is presented here as a guide for others to create a puppet show or other creative activity about metric measures.

Joyce/Chicquette/Knoepke/Hauser/Kluever

Waldo: They divided the distance around the earth into many small parts. Each part they called a "meter", the word which means measurement. You probably have seen a "meter stick" and noticed it is slightly longer than a yard stick. If you could place meter sticks end to end, 10 million of them would reach from the equator to the North Pole, one-fourth of the way around the earth.

The meter stick is divided into 100 smaller pieces called centimeters, and each centimeter is about the width of a pencil. This is something like the way the American dollar is divided into 100 cents.

Teacher: Very good! Now Phoebe, would you tell us about the liter?

Phoebe: The French scientists at first measured quantities of liquid in centimeters. A box 10 centimeters high, 10 centimeters wide and 10 centimeters deep would hold an amount of water they called a liter. The paper carton your milk comes in holds about one liter, a little more than a quart. The liter is divided into smaller units called centiliters (1/100th) and milliliters (1/1000th) of a liter.

Teacher: All right, and Priscilla, would you read about the gram?

Priscilla: The metric measuring unit used to measure mass or weight is called the gram. It is about the weight of a paper clip. Since many things weigh much more than a paper clip, a bigger weight measurement is used called a kilogram or 1,000 grams. A kilogram is about twice as heavy as a pound.

With the three basic metric units - the meter, liter and the kilogram - we can measure everything in the metric system. It is a convenient system and is easier to work with than other systems.

Teacher: Now I am going to pose a problem to you. If a meter is divided into 100 centimeters, and you wanted to measure your desk top, would you use inches or centimeters?

Waldo: Inches

Teacher: I think we have a problem.

Mice: (Sing to tune of "How Do You Solve A Problem Like Maria.")

"HOW DO YOU SOLVE A PROBLEM LIKE THE METER:

HOW DO YOU TAKE A YARD AND BREAK IT DOWN."

Teacher: Now settle down class. I can see that this isn't going to work. Now Phoebe Footmouse, does the metric system use inches and feet?

Phoebe: Yes, it does Miss Millie Meter.

Teacher: Class, aren't you catching on yet?

Mice: (Sing to tune of "I've Grown Accustomed to Your Face.")

"WE'VE GROWN ACCUSTOMED TO THE YARD,

WE'VE GROWN ACCUSTOMED TO THE FOOT,

WE'VE GROWN ACCUSTOMED TO THE INCH, THE POUND, THE MILE,

THE QUART, THE PINT ---"

Teacher: All right class. I think we need our milk break at this time.

(under breath, - "And it couldn't come at a better time! !")

Mice: (Sing to tune of "Everything is Coming Up Roses.")

"GET THE MILK, GET THE CHEESE:

I'LL HAVE TWO GRAMS OF CHEESE IF YOU PLEASE!"

Teacher: Class, is all of that noise necessary? Now settle down and enjoy your milk and cheese.

Mice: (Sing to the tune of "Tea for Two.")

"A GRAM FOR YOU, A GRAM FOR ME;

A LITER FOR YOU, A LITER FOR ME"

Teacher: That is enough for our milk break time. Now we are going to engage in some actual measuring activities. Now class, I want you to take your metric rulers and measure the width, in centimeters of our principal's picture. Does everyone have their meter stick in their hand?

Mice: (Sing to tune of "The Two of Us.")

"THE METER STICK: DA DA DA DA - DA DA DA DA

THE METER STICK . . . ."

Teacher: Now let's get busy because I want to see what your answer is. You may work on this as a group

(Pause and then ask for answer)

Mice: Give answer in centimeters.

Teacher: That was very good class. You are catching on. Now I want you to weigh yourselves and record your answers in grams.

(Pause while measuring is taking place)

The answers are what, Priscilla?

Priscilla: Gives answers.

Teacher: Did you find out anything else?

Mice: (Sing to the tune of "You Gotta Have Heart.")

"YOU ... GOTTA HAVE GRAMS

ALL YOU REALLY NEED IS GRAMS

WHEN THE KIDS ARE SAYING "WE USE THE POUND

TELL THEM YOU FOUND A WAY . . . ."

Teacher: If you students don't behave, I'll slap your paws with a meter stick. Now we are going to measure our height in millimeters.

What did you find your new height to be?

Waldo: Gives answers

Teacher: What do you think of the metric measures you used today?

Mice: (Sing to the tune of "Everything is Coming Up Roses.")

"EVERYTHING IS COMING UP METERS, AND LITERS, AND GRAMS!!!"

Phoebe: Why don't we use the metric system in the U.S.?

Teacher: We do, Phoebe. Pattern companies now use the metric system of measuring in addition to the English system. In our hospitals and laboratories everything is measured in meters and grams. Even the food in the supermarket is starting to include the weight of food in grams on its can labels.

Can each of you think of a way that you could use the metric system to measure everyday objects?

Phoebe: Road signs could be measured in kilometers instead of miles.

Teacher: Fantastic Phoebe. Priscilla, can you think of an idea?

Priscilla: Gas could be sold in liters instead of gallons.

Teacher: Perfect Priscilla. Waldo, can you contribute something?

Waldo: The Miss Amousica pageant could use centimeters for the contestants' measurements.

Teacher: Well class, those were great suggestions. Are there any more final comments?

Mice: (Sing to tune of "Cabaret.")

Mice: (cont.) "WHAT GOOD IS USING THE YARD STICK TODAY

COME JOIN THE METRIC WAY . . ."

Teacher: Now settle down class. I'm glad to see you feel that way. What generalizations have you made about the metric system, Waldo?

Waldo: (Sing to tune of "People.")

"PEOPLE ... PEOPLE WHO USE METRIC
ARE THE SMARTEST PEOPLE IN THE WORLD."

(BELL RINGS)

Mice confer over in the corner.

Teacher: What's going on over there in the corner?

Mice: Grand Finale

(Sing to tune of Mickey Mouse song.)

" M E T ...... TRY IT, YOU'LL LIKE IT
R I C ...... SEE, IT'S EASY TO USE
S Y S T E M
METRIC SYSTEM ...... METRIC SYSTEM
FOREVER LET US HOLD OUR METERS HIGH ...
NOW IT'S TIME TO SAY GOODBYE TO YARDSTICKS, QUARTS,
AND POUNDS
M E T ...... WE TRIED IT, WE LIKED IT
R I C ...... SEE, YOU'LL LIKE IT TOO,
S Y S T E M "

POSTTEST OVERVIEW OF METRIC SYSTEM (Module 1)

1. What is the basic unit of length in the metric system? 1. ____________

2. In which country did metric measurement originate? 2. ____________

3. Name the only major country that does not use the metric system. 3. ____________

4. What is the basic unit of volume in the metric system? 4. ____________

5. What is the basic unit of mass in the metric system? 5. ____________

6. A meter is ________(longer/shorter) than a yard. 6. ______________

7. A quart is ________(larger/smaller) than a liter. 7. ____________

8. Which system of measurement uses the number 10 as its base? 8. ____________

9. The gram is ________(heavier/lighter) than the pound. 9. ____________

10. Modern measurement systems have units that are always the same. These are called ____________ units. 10. ____________

Objectives

The participant will be able to:

1. identify and describe with examples the basic unit of metric length.
2. define and describe with examples the six basic prefixes used in the metric system, using length as a base.
3. indicate the standard abbreviations for the six basic prefixes as applied to length.
4. accurately measure materials of a variety of lengths using the six basic prefixes.
5. identify instances where he or she would use each of the six units of metric length in daily living.

Suggested Activities to Meet Objectives

1. Read the handout on "Metric Length and Common Prefixes."
2. Study "Summary Chart on Metric Prefixes and Length Units."
3. Read the fable, "The Friendly Cloth Merchant."
4. Play the game, METRIC CONCENTRATION.
5. Complete worksheet, "How Long Are the Kite Tails?"
6. Work crossword puzzle, METRIC LENGTH.
7. Play card game, MIX-A-METER.
8. Complete learning center activities 1 and 2 on "Metric Length."

Illustration of Mastery

1. Agreement of "satisfactory" between instructor and participant on completion of:
   a. "How Long Are the Kite Tails?" worksheet
   b. "Metric Length" learning center activity #1
   c. "Metric Length" learning center activity #2
2. Completion of "Metric Length Unit - Posttest" with 80 percent accuracy.

Being introduced to a new measuring system can be like meeting a new friend. First you learn his name so you can identify him and get a general impression of what he looks like.

After you've known him a few minutes you start to get more detailed information--where he lives, what his work is, where he went to school.

Finally, after you have known him a while, you learn what he likes, what his beliefs are, what his goals in life are, and more complex things that make up his total personality.

You are going to be introduced to a new friend, Mr. Metric. Mr. Metric has three dimensions--length, volume, and weight--which together make up his total character or "personality".

In this first meeting, we will get our first impression of Mr. Metric, which is the measurement of length. After getting well acquainted with length we"ll go on to volume and weight until we know the total Mr. Metric.

The basic unit of length is the meter, which means "to measure". From the word meter comes our word "metric" for the whole system. How big is a meter? It's about the distance from your nose to your finger tips, about the length of a tall man's stride. This gives you a quick estimate of the distance, so you know in general what you are dealing with. But a meter is a precise amount. It is one-ten millionth of the distance from the equator to the North Pole.

You won't always want to work with a measure as long as your arm, so the meter is divided into smaller units. One division is a decimeter, or one-tenth meter, about the width of a letter size envelope or about as wide as a man's hand.

A smaller unit is a centimeter, or 1/100th of a meter. It is a little more than the width of a pencil or a paper clip, a little less than the width of your little finger.

For very fine measurements we use the millimeter, or 1/1000th of a meter. It is about the thickness of a paper clip, the lead of a well-sharpened pencil, or the thickness of the cardboard on a tablet of paper.

How do you remember these names? Start out by association with something you know, like money. Think of the meter as a dollar. Then a decimeter is a 10th of a meter just as a dime is a tenth of a dollar. You can even see the word "dime" in decimeter. DecIMEter.

A cent is 100th of a dollar and a centimeter is a 100th of a meter. What could be more simple than that?

We don't deal very much with a mill, 1/100th of a dollar, except when figuring taxes, like a 1 mill rate, which is 1/1000th of a dollar taxed on

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every dollar value. A thousandth of a dollar is a mill; a thousandth of a meter is a millimeter.

We also need to go up the scale for measurements that are too big to measure with a meter stick. Ten meters is called a dekameter, and it's about the width of a residential street or two-lane country road. Dekameter sounds a little bit like the word "decade". A decade is 10 years, a dekameter is 10 meters.

Another long measure of length is 100 meters or a hectometer. This is a little longer than the length of a football field or the distance to the outfield fence in a major league ball diamond. It's a little more than 100 paces and about the distance an average adult can walk in a minute, though our fastest athletes run it in about one-fifth that amount of time.

The longest metric measuring unit is the kilometer or 1,000 meters. It's the unit you hear of most often in measuring road distances, rivers and lakes, and other geographic features. The distance from the equator to the North Pole is a convenient 10,000 kilometers, making the distance around the earth 40,000 kilometers. The prefix "kilo" comes from a Greek word meaning 1,000. You've heard this used in terms of electric power. A kilowatt is 1,000 watts; a kilometer is 1,000 meters.

Thus we have a convenient scale of measure, with each unit ten times as big as you go up the scale--milli-, centi-, deci-, meter, deka-, hecto-, and kilo-. Or you can say that each unit is one-tenth as big as you go down the scale from the biggest unit--kilo-, hecto-, deka-, meter, deci-, centi-, and milli-.

The metric scale has some other units for extremely large or extremely small distances on both ends of the scale, but the units will not be used except in special cases and you can learn them when you need them. If you master the scale from milli- to kilo-, you will not have any trouble with any part of the metric system that you will encounter later.

By the way, you don't have to write out a long word like millimeter and centimeter. These units of metric length all have neat abbreviations as follows: Millimeter-mm, centimeter-cm, decimeter-dm, meter-m, dekameter-dkm, hectometer-hm, and kilometer-km.

So you have been introduced to a new friend, Mr. Metric and have become enough acquainted with him so you'll recognize him next time you see him. You now know one dimension of his total person called length. Next time you see him, you'll get to know him better and learn about another side of him, called volume. Later on, in a third meeting, you'll get the last dimension of Mr. Metric called mass or weight.

SUMMARY CHART ON METRIC PREFIXES AND LENGTH UNITS

Prefix Name	Prefix Symbol	Definition	Name of Length Unit	Symbol for Length Unit
kilo	k	1,000	kilometer	km
hecto	h	100	hectometer	hm
deka	dk	10	dekameter	dkm
--	--	1	meter	m
deci	d	.1	decimeter	dm
centi	c	.01	centimeter	cm
milli	m	.001	millimeter	mm

THE FRIENDLY CLOTH MERCHANT (Module 2)

(A Fable About Measurement)

Long ago there lived a cloth trader named Obed in a faraway land. Obed was a very tall man with long arms that stretched like wings when he held up cloth for his customers to see. He was a friendly man, but not considered very wise by other men in the market.

Business was very good, and customers came from a great distance to buy cloth from Obed. One day a famous tentmaker came to buy cloth.

"How much do you want?, Obed asked him.

"About a hundred arm's length", the tentmaker replied.

"That's a great amount," Obed said, "but I can sell it to you and then buy more."

He stretched his great arms and folded the cloth back and forth 100 times and draped it over the tentmaker's donkey for his trip back home.

"You have bought almost all my cloth", Obed told the tentmaker, "but with your money I can go and buy more."

The tentmaker smiled as he rode away thinking, "Oh, how nice to buy from such a big, friendly man."

Next day Obed had to go to the next village to buy more cloth from the man who always sold it to him. Ali was a very little man, but he was also friendly and much wiser than Obed.

"A customer just bought all my cloth", Obed said. "I need to replace it so I can sell again tomorrow."

"How much did your customer buy?", Ali asked.

"One hundred arms lengths", said Obed.

"Ah, that is a lot of cloth, but I can sell it to you", he said. And he stretched his short arms out and measured the cloth until he had 100 lengths.

Obed paid Ali, loaded the cloth on his donkey, and trudged down the road back to his shop.

Next day business was good again. Obed measured 10 arm lengths for his first buyer, then 5, then 20. By the end of the day he had stretched out the cloth in his great arms many times and the cloth was all sold.

He returned to Ali in the evening and said, "I have sold all the cloth and I must replace it again. I will take 100 lengths more. Ali stretched out

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his tiny arms and measured 100 lengths again. Obed paid him, went back to the shop, and was ready to sell the next day.

This brisk trade continued for many days. The cloth was sold out each day, and Obed was pleased that he could always buy as much as he needed to sell the next day.

Then one day he counted his money and found that he did not have enough to buy as many lengths of cloth as he needed. So he bought less and again the cloth sold out rapidly. Each time he returned to buy more cloth his money bought less and he sold out faster. One day Obed realized that although he had many customers, a brisk trade, and a good supplier of cloth, he was getting poor instead of rich. Finally he had to close his shop.

Now the moral of this fable is: No matter how much trade you have or how friendly you are to your customers, a poor measuring standard can put you out of business.

GAME METRIC CONCENTRATION (Module 2)

Materials: 16 cards - -

7 marked with metric prefixes or terms (kilo, hecto, deka, unit, deci, centi, milli)

7 marked with numerical equivalents (1,000, 100, 10, .1, .01, .001)

2 marked "wild card"

Players: 3 - 4

Rules:

1. The cards are shuffled and placed face down in four rows, 4 cards per row.

2. The player to the left of the dealer selects two cards and turns them up in their places.

   If the cards show a prefix and its numerical equivalent, it is a match, and the player picks up the 2 cards and sets them in front of him. His turn resumes by picking two more cards.

   If the cards do not match, they are turned face down in their places and the turn is over.

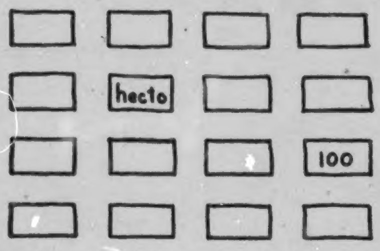
   If a "WILD CARD" is picked, the second card chosen with it makes an automatic match. The player then takes the matched cards and picks two more cards.

   A player's turn continues until two cards which do not match are turned up.

3. Play proceeds moving clockwise around the group.

4. The game ends when no more matches can be made (because of the wild cards, it is possible that the game will end with 2 cards still on the table).

5. The player who has the most cards is the winner.



The matches are: kilo--1,000 hecto--100 deka--10
unit--1 deci--.1 centi--.01 milli-.001

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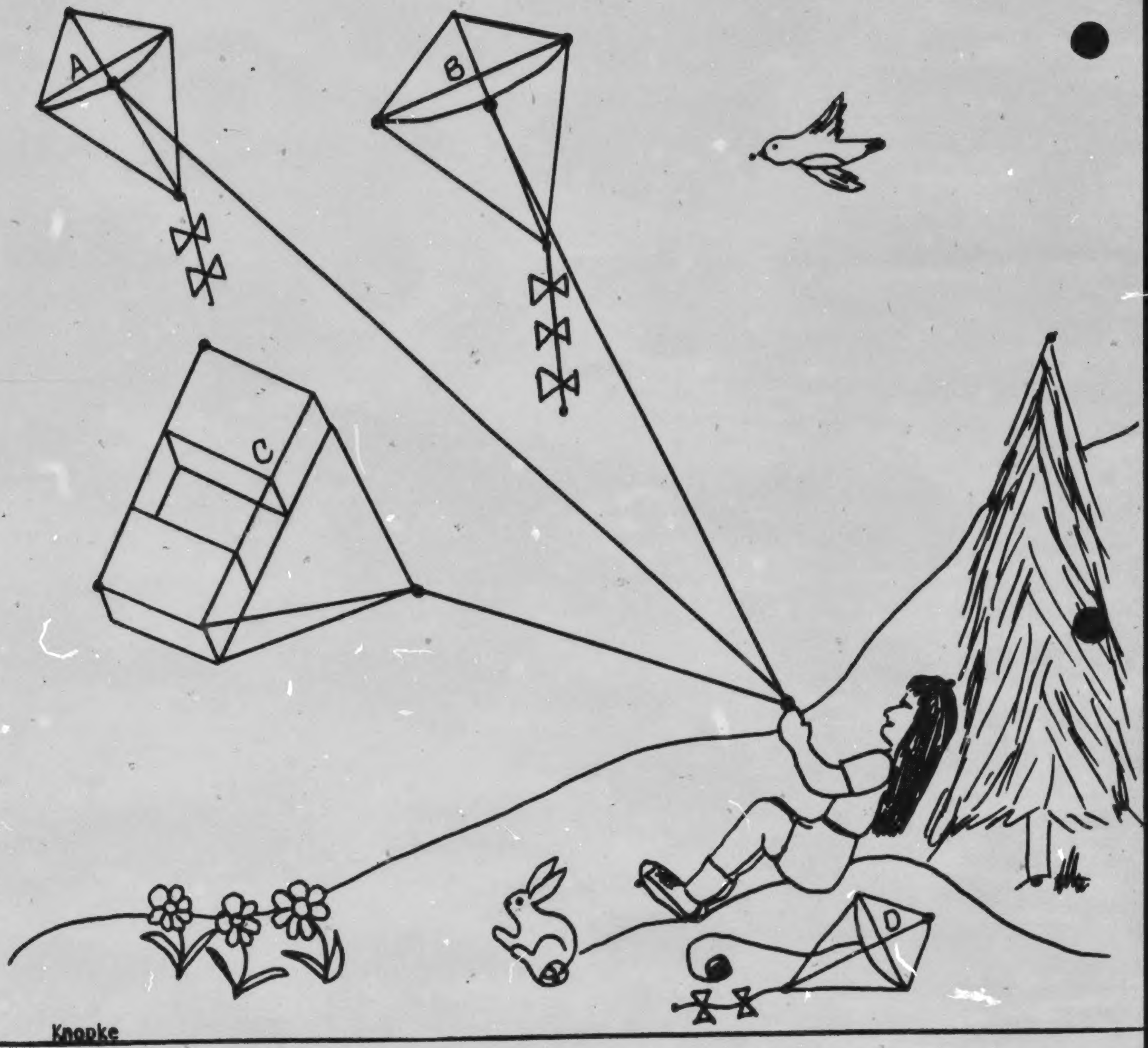
HOW LONG ARE THE KITE TAILS?

(Module 2)



1. How long is Kite A? ________cm

2. How wide is Kite B? ________mm

3. How long is the string on Kite A? ________cm

4. How long is Kite C? ________mm

5. How long is the string on Kite C? ________cm

6. How long is Kite D? ________cm

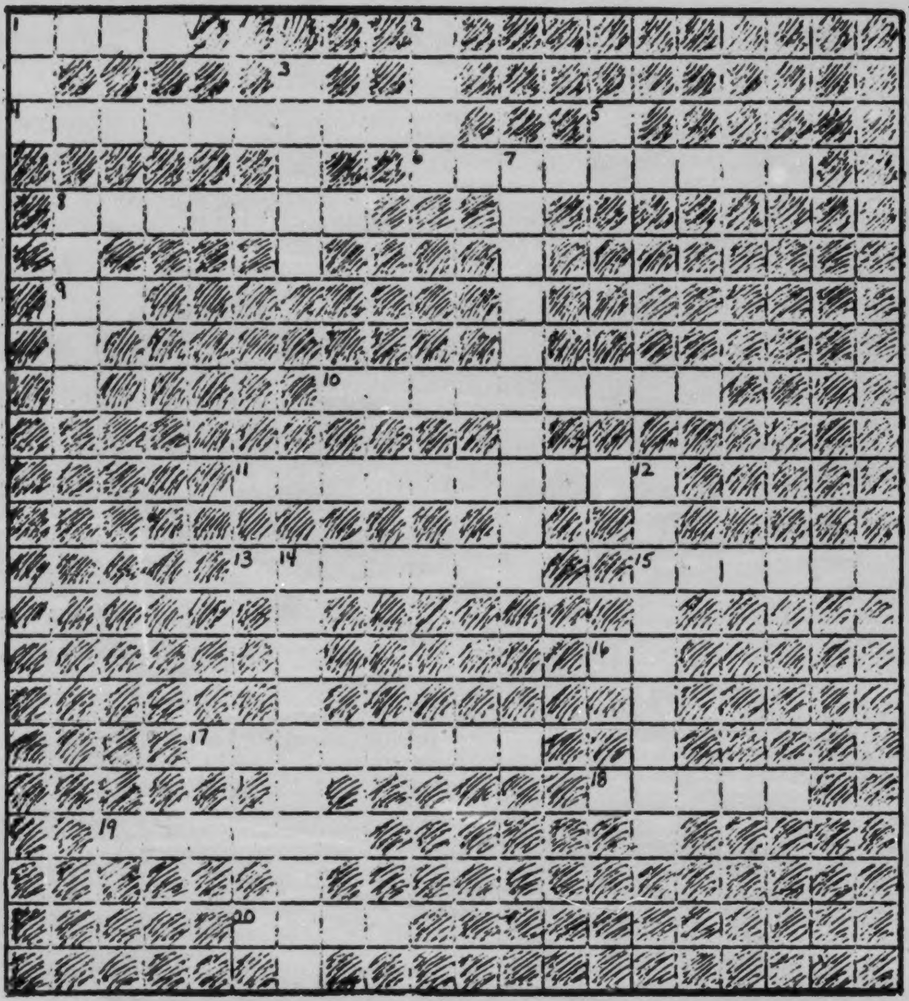
7. How long is the tail on Kite D? ________mm

8. How long is the bird? ________mm

9. How tall is the tree? ________dm

10. How long is the girl from head to toe? ________cm

METRIC LENGTH CROSSWORD PUZZLE (Module 2)



Across

1. prefix meaning ten
4. .001 meter
6. .1 meter
8. A meter is one ____ centimeters.
9. abbreviation for centimeter
10. 10 meters
11. A meter is measured by a ____ ____.
13. A yard is ____ than a meter.
15. A meter is a unit of ____.
16. abbreviation for kilometer
17. A meter is one ____ millimeters.
18. A prefix meaning hundredth
19. A meter is ____ than a yard.
20. prefix meaning tenth

Down

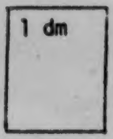
1. abbreviation for dekameter
2. English unit to measure cloth
3. standard metric unit of length
5. abbreviation for millimeter
7. 10 millimeters
8. prefix meaning hundred
12. 1000 meters
14. 100 meters

GAME **MIX-A-METER** **(Module 2)**

Materials: 30 cards as follows:

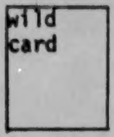
1 dm	10 cm	100 mm
2 dm	20 cm	200 mm
3 dm	30 cm	300 mm
4 dm	40 cm	400 mm
5 dm	50 cm	500 mm
6 dm	60 cm	600 mm
7 dm	70 cm	700 mm
8 dm	80 cm	800 mm
9 dm	90 cm	900 mm

27 with the units shown here written in the upper left hand corner



sample

3 wild cards as indicated here



sample

Players: 3 - 5

Rules:

1. Dealer shuffles cards and deals 5 cards to each player. The rest of the cards are placed face down on the table.
2. The player to the left of the dealer takes the top card from the pile and tries to "make" a meter by combining 2 of the six cards in his hand.

   Combine only like units, such as 200 mm and 800 mm, or 90 cm and 10 cm.

   A wild card can have any value.

   If the player makes a match, he places the matched cards on the table in front of him.

   The player discards one card from his hand.
3. The next player has the option of picking up the discard or taking the next card from the pile and trying to make a match.
4. Play continues until one person is out of cards.
5. If the pile is exhausted before any player is out, the discard pile is shuffled and placed face down.
6. The first player to be out of cards is the winner.

Variations:

1. Combine different units such as 3 dm (equals 30 cm) and 70 cm to equal a meter.
2. Allow more than two cards to be used to make the meter (7 dm, 20 cm, 100 mm).

Taken from Teacher (#6), February 1974: "Mix-A-Meter" Hazel B. Williams, Detroit, MI.

Learning Center Activity #1 METRIC LENGTH (Module 2)

EQUIPMENT NEEDED: Cm measuring sticks or tapes, paper clips, crayons, pencils, books, chalkboard erasers

Look at each item listed below. Estimate its length in the units indicated. Record your estimate. Then measure the item and record its actual length.

	Estimate	Measurement
1. paper clip (millimeters - length)	________mm	________mm
(millimeters - width)	________mm	________mm
2. crayon (millimeters - length)	________mm	________mm
3. pencil (millimeters - length)	________mm	________mm
4. book (centimeters - length)	________cm	________cm
(centimeters - width)	________cm	________cm
5. chalkboard eraser (centimeters - length)	________cm	________cm
(centimeters - width)	________cm	________cm
6. your hand from the top of the middle finger to your wrist (centimeters)	________cm	________cm

7. Choose three other objects. Estimate their length or width. Record the estimate and measurements.

Object		
____________	________	________
____________	________	________
____________	________	________

Learning Center Activity #2 METRIC LENGTH (Module 2)

EQUIPMENT NEEDED: metric tape measures, cm sticks, meter sticks

Look at each object listed below. Estimate its length in the units indicated. Then measure the object and record the measurement.

	Estimate	Measurement
1. length of desk or table	____________ dm	____________ dm
2. length of chalkboard or bulletin board	____________ dm	____________ dm
3. height of wastebasket	____________ dm	____________ dm
4. your height	____________ m	____________ m
5. height of a door	____________ m	____________ m
6. length of a wall in the room	____________ m	____________ m

7. Find out how long a kilometer is. Make a route in the building or on the playground. Write instructions on the path to take. Describe the procedures you use below. Include a diagram of your path.

METRIC LENGTH UNIT - PRETEST* Module 2

Section I Directions: Write the letter of the correct response in the blank to the left of each statement.

1.__________The height of a door is about

a. 5 meters
b. 4 meters
c. 10 meters
d. 1 meter
e. 2 meters

2.__________With an outstretched arm and hand, the distance from the tip of the nose to the tip of the index finger is about equivalent to one

a. hectometer
b. kilometer
c. centimeter
d. meter
e. dekameter

3.__________10 millimeters is equal to

a. 1 centigram
b. 10 decimeters
c. 1 dekameter
d. 1 centimeter
e. 10 meters

4.__________John used a basic metric unit of length to measure the science table. He used the

a. gram
b. meter
c. foot
d. cubit
e. Fahrenheit

5.__________To find the length of a table tennis paddle, which of the following units would be used?

a. milligram
b. deciliter
c. centimeter
d. decibel
e. hectogram

*Keehn, 1974 as adapted from Jahr and Wagner

Metric Length Unit - Pretest (cont.)

6.__________4000 meters is equal to

a. 40 meters
b. 4 kilometers
c. 4 millimeters
d. 4 centimeters
e. 400 millimeters

7.__________Ten meters equals 1

a. kilometer
b. centimeter
c. decimeter
d. dekameter
e. hectometer

Section 2 Directions: Place the answer on the line in front of each problem.

8. Write the symbols for the following metric units.

_________________________a. centimeter

_________________________b. millimeter

_________________________c. hectometer

_________________________d. kilometer

_________________________e. decimeter

9. Give the number (whole numbers or fractions) for the prefixes listed below:

_________________________a. kilo

_________________________b. hecto

_________________________c. deka

_________________________d. deci

_________________________e. centi

_________________________f. milli

10. Indicate the relationship between the following measures in the metric system by writing in the words greater than or less than in the blank to the left of each statement.

______________________ a. 100 milliliters is --- 100 centiliters

______________________ b. 50 kilometers is --- 50 hectometers

______________________ c. 1,000 kilograms is --- 1,000 grams

______________________ d. 10 centiliters is --- 10 liters

______________________ e. 87 milligrams is --- 87 centigrams

11. Using the given list of metric units, identify which unit could best be used to measure each of these objects.

Given: millimeter, centimeter, meter, hectometer, kilometer

______________________ a. length of a sheet of paper

______________________ b. length of a football field

______________________ c. distance from New York to Buffalo

______________________ d. length of an insect

______________________ e. height of a telephone pole

12. Using a metric ruler, draw a line segment within the parentheses that is the length given. Label each line and make the end points clear.

( ) a. 5 centimeters long

( ) b. 7 millimeters long

METRIC LENGTH UNIT - POSTTEST* Module 2

Section I Directions: Write the letter of the correct response in the blank to the left of each statement.

__________1. Which of the following are closest to one centimeter in length?

a. length of your thumb
b. length of a ballpoint pen
c. standard sized paper staple
d. wire paper clips
e. blackboard eraser

__________2. What part of a kilometer is equal to a hectometer?

a. 1/100th
b. 1/10th
c. 1/1000th
d. 1/10000th
e. 1/2

__________3. Charlie Brown measured his tree house and the meterstick read 10 meters. This is the same as a:

a. kilometer
b. centimeter
c. decimeter
d. dekameter
e. hectometer

__________4. The metric unit, millimeter, could be used to measure the

a. amount of milk in a glass
b. weight of a feather
c. width of your eye's pupil
d. volume of a fountain pen
e. heaviness of a plant's leaf

__________5. Ten dekameters are equivalent to

a. 10 meters
b. 100 centimeters
c. 1,000 meters
d. 10 millimeters
e. 100 meters

---

*Keehn, 1974, as adapted from Jahr and Wagner

_________6. Jim Ryan ran the 100 meter dash in 35 seconds. How many hectometers did he run?

a. 1000
b. 100
c. 10
d. 1
e. .1

_________7. Which of these symbols means decimeter?

a. dl
b. dka
c. dcl
d. dm
e. dcg

_________8. Which of these prefixes means 1/100th?

a. hecto
b. deci
c. kilo
d. centi
e. deka

_________9. The meter is the basic unit of metric

a. volume
b. length
c. weight
d. temperature
e. time

_________10. 1 dekameter is equivalent to

a. 10 meters
b. 100 centimeters
c. 1,000 meters
d. 10 millimeters
e. 100 meters

Section 2 Directions: Write the answer in the answer block to the right of each problem.

11. Write in either centimeter or kilometer as the appropriate measure.

a. Paper clips are about 3 ____ long. 11a. 3________________

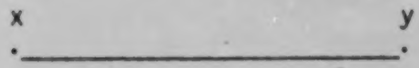
b. City blocks are about 1/5 ____ long. 11b. 1/5________________

c. New pencils are about 18 ____ long. 11c. 18________________

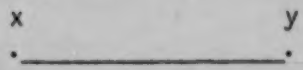
d. Madison is about 240 ____ from Chicago. 11d. 240________________

12. Estimate the distance in meters from the school building to the street indicated by your teacher. 12. ________________meters

13. Measure these line segments to the nearest centimeter.

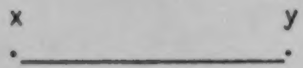
a.


13a. ____________________

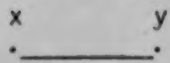
b.


13b. ____________________

14. Measure these line segments to the nearest millimeter.

a.


14a. ____________________

b.


14b. ____________________

15. How many kilometers in 5,000 meters? 15. ____________________km

Objectives

The participant will be able to:

1. identify and describe with examples the basic unit of volume
2. apply the six prefixes to the volume unit
3. accurately measure materials holding a variety of volumes using the six basic prefixes
4. identify instances where he/she would use each of the six units of volume in daily life

Suggested Activities to Meet Objectives

1. Read the handout, "Metric Volume Units."
2. Study the "Summary Chart on Metric Volume Units".
3. Play game, "Liter Lotto".
4. Work crossword puzzle, METRIC VOLUME.
5. Complete learning center activities 1, 2 and 3 on metric volume.

Illustration of Mastery

1. Agreement of satisfactory between instructor and participant on:
    a. learning center activity #1
    b. learning center activity #2
    c. learning center activity #3
2. Completion of "Metric Volume Unit Posttest" with 80 percent accuracy.

METRIC VOLUME UNITS

(Module 3)

You've met Mr. Metric. In your first meeting you got a look at one dimension of him called length. Now you'll get to know him better as you learn something else about him called volume, or capacity.

His volume is measured in a basic unit called the liter. The liter measures 10 centimeters long by 10 centimeters high by 10 centimeters deep or 1,000 cubic centimeters. It is a little larger than a quart.

We can divide a liter into tenths and call each part a deciliter; into hundredths, a centiliter; and into thousandths, a milliliter. The most commonly used volume terms are liter and milliliter. To get an idea of size of a milliliter, remember that there are 5 milliliters in a teaspoon. The deciliter and centiliter are used for cooking and meal service.

When we go larger than a liter, we call 10 liters a dekaliter; 100 liters a hectoliter, and 1,000 liters a kiloliter. Traditionally, the liter is used to measure the volume of liquids. For the volume of solids such as cement and stone, we use the term cubic meter, rather than kiloliter. A cubic meter is one million cubic centimeters (100 cm x 100 cm x 100 cm) or one million milliliters (1,000 ml x 1,000) or 1,000 liters. A cubic meter is a little larger than a cubic yard. The volume of gases is also traditionally measured in cubic meter or related units.

Remember to use the prefixes for volume in the same way as you used them for length - milliliter (1,000th liter), centiliter (100th liter), deciliter (10th liter), liter, dekaliter (10 liters), hectoliter (100 liters), kiloliter (1,000 liters).

Symbols for volume measures are similar to length: ml, milliliter; cl, centiliter; dl, deciliter; l, liter; dkl, dekaliter; hl, hectoliter; and kl, kiloliter.

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SUMMARY CHART ON METRIC VOLUME UNITS (Module 3)

NAME OF VOLUME UNIT	SYMBOL FOR VOLUME UNIT	DEFINITION OF VOLUME UNIT
kiloliter	kl	1,000 liters
hectoliter	hl	100 liters
dekaliter	dkl	10 liters
liter	l	1 liter
deciliter	dl	.1 liter
centiliter	cl	.01 liter
milliliter	ml	.001 liter

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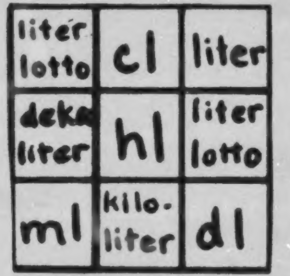
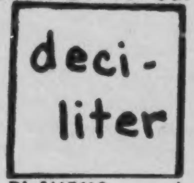
Game

LITER LOTTO

(Module 3)



LITER LOTTO card



PLAYING card

Materials: LITER LOTTO CARDS:
Card is divided into 9 spaces. Two spaces are marked liter lotto; other spaces are marked with a word or symbol from this list:

kiloliter	- kl	deciliter	- dl
hectoliter	- hl	centiliter	- cl
dekaliter	- dkl	milliliter	- ml
liter	- l		

Deck of 28 playing cards. Each deck contains two sets of words and two sets of symbols from the list shown above.
(Use 1 deck for 2-3 players, use 2 decks for 4-6 players)

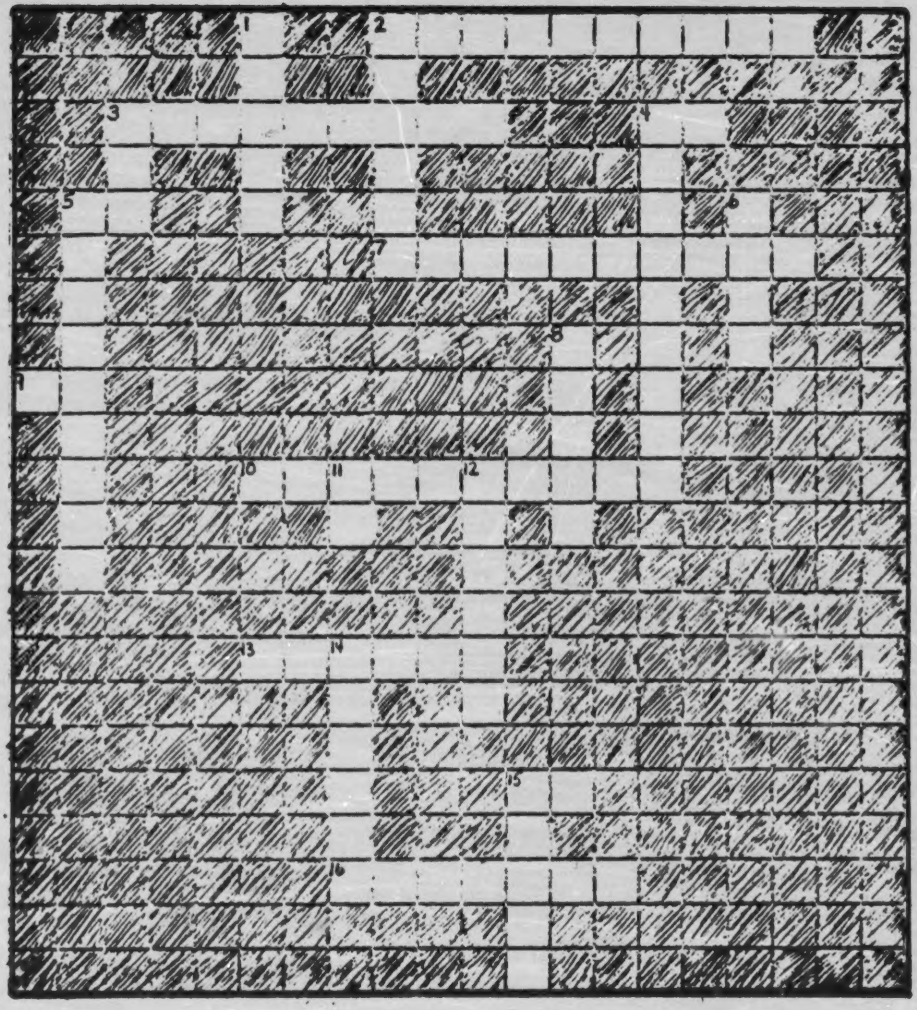
Players: 2 - 6

Rules:

1. Each player takes a large LITER LOTTO card.
2. The deck of cards is shuffled and placed face down in the center of the playing area.
3. The object of the game is to cover each space on the LITER LOTTO card with an equivalent card from the deck. LITER LOTTO spaces are free and do not need to be covered.
4. The first player picks the top playing card from the deck and tries to match it with a word or symbol on his/her LITER LOTTO card.
   Words are matched with symbols and symbols are matched with the corresponding words. (Pairing a word with a word or a symbol with a symbol does not make a match!)
5. If the player can make a match, the playing card is placed on the corresponding space on the LITER LOTTO card; this completes a turn.
6. Play rotates clockwise around the table.
7. The next player may pick up the top card from either the discard pile or the deck.
8. If the deck pile is used up, the discard pile is shuffled, placed face down on the table and becomes the deck.
9. The winner is the first person to cover all except the free spaces on the LITER LOTTO card.

METRIC VOLUME CROSSWORD PUZZLE

(Module 3)



ACROSS

2. .001 liters.
3. 10 liters.
4. Abbreviation for deciliter.
5. Abbreviation for kiloliter.
7. .01 liters.
9. Abbreviation for hectoliter.
10. 100 liters.
13. A liter is a metric unit of ______.
15. Abbreviation for milliliter.
16. A quart is ______ than a liter.

DOWN

1. English unit to measure milk or oil for a car.
2. System of standard measure using meter, liter and and gram.
3. Abbreviation for dekaliter.
4. .1 liters.
5. 1000 liters.
6. Prefix meaning tenth.
8. Prefix meaning hundredth.
11. Abbreviation for centiliter.
12. A liter is ______ than a quart.
14. Basic metric unit of volume (plural).
15. Prefix meaning thousandth.

Learning Center Activity #1 METRIC VOLUME (Module 3)

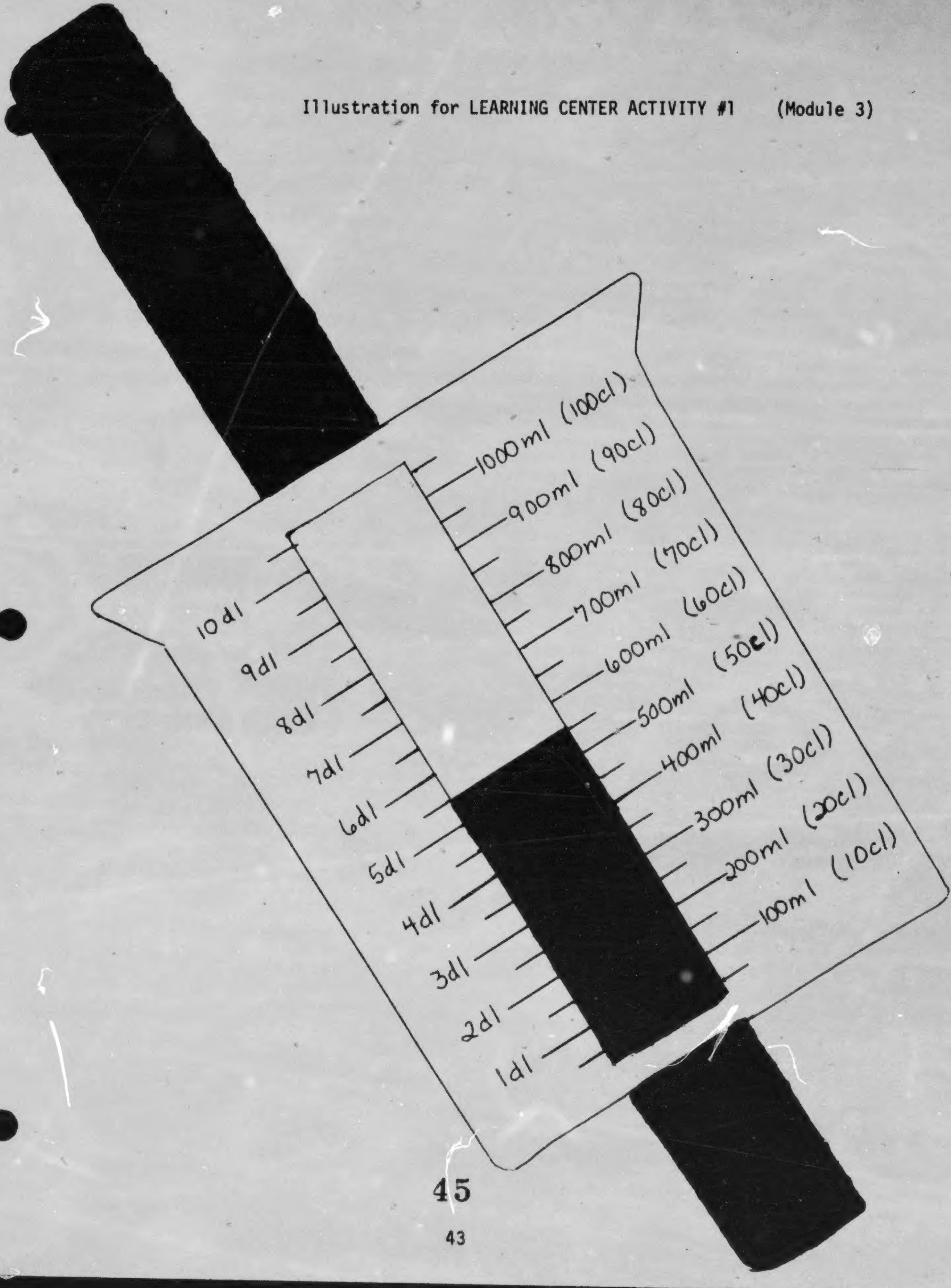
EQUIPMENT NEEDED: beakers - made out of cardboard with slots cut above and below the volume marking; a strip of paper, half red and half white, is woven into the open center (see illustration, p. 44). The beakers work on the same principle as paper thermometers used with primary children.

The students work in small groups (4-5). Each group can work with one beaker or, if possible, each person can have a beaker.

The instructor can present measurements in liters and have the students pull the strip so that the red part marks the designated measurement. Or the students may be asked to work through the following activities independently:

1. How big is your beaker?
   a. How many deciliters is that?
   b. How many centiliters is that?
   c. How many milliliters?
2. Make your beaker show 500 ml.
3. Make your beaker show 5 dl.
4. Make your beaker show 20 cl.
5. Make your beaker show 2 dl.
6. Make your beaker show 100 cl.
7. Make your beaker show 7 dl.
8. Show 5 dl and write two other ways of showing this same level of measure.
9. Show 8 dl and write two other ways of showing this same level of measure.
10. Show 3 dl and write two other ways of showing this same level of measure.

Illustration for LEARNING CENTER ACTIVITY #1 (Module 3)



1000ml (100cl)
900ml (90cl)
800ml (80cl)
700ml (70cl)
600ml (60cl)
500ml (50cl)
400ml (40cl)
300ml (30cl)
200ml (20cl)
100ml (10cl)
10dl
9dl
8dl
7dl
6dl
5dl
4dl
3dl
2dl
1dl

Learning Center Activity #2   METRIC VOLUME   (Module 3)

EQUIPMENT NEEDED: bucket containing more than one liter of colored water, quart containers, liter containers (with ml markings), 5 paper cups, extra container (at least 500 ml), graduated cylinders.

1. Fill the quart container with colored water. Pour the water from the quart container into the liter.

   Which is more, the quart or the liter? 1.____________________

2. Add enough water to fill the liter. Pour half of the liter of water into another container.

   How many milliliters are left? 2a.____________________

   How many centiliters are left? b.____________________

   How much is that in deciliters? c.____________________

3. Set 5 paper cups on the table. Try to divide 500 ml of water equally into the five cups. Find out how much water is in each cup by pouring it into a graduated cylinder.

   How many milliliters is it? 3a.____________________

   How many centiliters is it? b.____________________

   How many deciliters is it? c.____________________

Empty the water back into the original container. Be sure the station is neat when you have finished.

Kluever/Sorenson

Learning Center Activity #3 METRIC VOLUME (Module 3)

EQUIPMENT NEEDED: Water, liter measure, drinking glass, baby food jar, coffee cup, assorted containers

1. Look at the liter measure. How many milliters does it hold? 1.____________

2. a. Estimate the capacity of the drinking glass. Record. 2a.____________

   b. Measure the amount of water the drinking glass actually holds. Record. 2b.____________

3. a. Estimate the capacity of the baby food jar. Record. 3a.____________

   b. Measure the water in the baby food jar. Record. 3b.____________

4. a. Estimate the capacity of the coffee cup. Record. 4a.____________

   b. Measure the water in the coffee cup. Record. 4b.____________

5. Choose other containers. Estimate their capacity, then measure. Record estimations and measurements.

Container	Estimate	Measurement
____________	____________	____________
____________	____________	____________
____________	____________	____________
____________	____________	____________

METRIC VOLUME - POSTTEST (Module 3)

1. What is the basic unit of volume in the metric system? 1. ____________

2. A quart is (larger/smaller) than a liter. 2. ____________

3. 1 liter = ________ milliliters 3. ____________

4. 1 liter = 100 ________ 4. ____________

5. 10 liters = 1 ________ 5. ____________

6. 100 ________ = 1 hectoliter 6. ____________

7. ________ liters = 1 kiloliter 7. ____________

8. 1 liter = ________ deciliters 8. ____________

Put the correct letter from the column on the right in front of the word on the left.

________ 9. kiloliter
________ 10. hectoliter
________ 11. dekaliter
________ 12. liter
________ 13. deciliter
________ 14. centiliter
________ 15. milliliter

a. hl
b. mg
c. ml
d. cg
e. kl
f. kg
g. cl
h. dl
i. l
j. dkl

Objectives

The participant will be able to:

1. identify and describe with examples the basic unit of mass.
2. apply the six basic prefixes to the mass unit.
3. accurately measure materials of different masses using the six basic prefixes.
4. identify instances where he/she would use each of the six units of mass in daily life.

Suggested Activities to Meet Objectives

1. Read handout, "Metric Mass Units".
2. Study the "Summary Chart of Metric Mass Units".
3. Play the game, "GUESS-A-GRAM".
4. Work the crossword puzzle, METRIC MASS.
5. Complete learning center activities #1 and #2.

Illustration of Mastery

The participant will illustrate mastery by:

1. agreement of "satisfactory" between participant and instructor on
    a. learning center activity #1
    b. learning center activity #2
2. completion of posttest on METRIC MASS with 80 percent accuracy.

METRIC MASS UNITS

(Module 4)

Now you know about Mr. Metric and the metric system in terms of length and volume. There is one more measurement which will give you the complete dimensions of the system. That measurement is mass.*

The basic unit of metric mass is the gram, which on earth is about the weight of a paper clip. It takes a little less than 30 grams to equal an ounce. The gram is a very small unit that is useful in scientific work, but the kilogram (1,000 grams) is the most convenient unit for everyday use. A kilogram is a little more than two pounds.

Units of mass are measured in smaller or larger amounts using the six prefixes you have now become acquainted with. A tenth of a gram is a decigram; 100th of a gram is a centigram; and 1,000th of a gram is a milligram. Going up the scale from the basic mass unit, the gram, you have 10 grams equal to a dekagram; 100 grams to a hectogram; and 1,000 grams to a kilogram. The most common mass units you will use are the milligram, gram and kilogram. Very large amounts of materials like coal and cement are measured in a 1,000 kilogram unit which is called a metric ton: it is slightly heavier than our familiar ton.

To review, the units of mass from small to large are: milligram (1/1000th gram), centigram (1/100 gram), decigram (1/10 gram), gram, dekagram (10 grams), hectogram (100 grams), kilogram (1,000 grams).

---

* Mass is defined as a quantity of matter. Weight is defined as a force. The force is the earth's gravitational pull or attraction for a given mass. Usually we mean mass when we use the term weight. On the earth, these two units are approximately identical, but out in space weight changes, while mass remains constant.

D. Sorenson

SUMMARY CHART ON METRIC MASS UNITS

(Module 4)

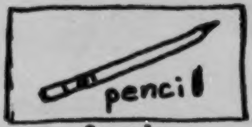
NAME OF MASS UNIT	SYMBOL FOR MASS UNIT	DEFINITION OF MASS UNIT
kilogram	kg	1,000 grams
hectogram	hg	100 grams
dekagram	dkg	10 grams
gram	g	1 gram
decigram	dg	.1 grams
centigram	cg	.01 grams
milligram	mg	.001 grams

Game

GUESS-A-GRAM

(Module 4)

Materials: 10 - 20 GUESS-A-GRAM cards, each illustrating a common object whose weight is to be estimated such as: pencil, ruler, tape dispenser, crayon, scissors, stapler, notebook



Sample

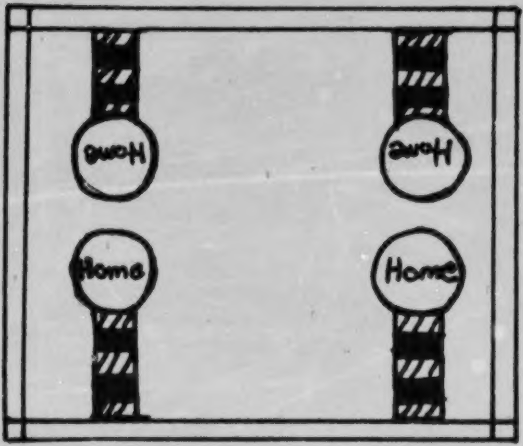
2 GUESS-A-GRAM cards marked CHOICE

collection of 10 - 20 objects which match the illustrations on the cards

balance scale and metric weights

sheet of paper and pencil for each player

GUESS-A-GRAM board (see illustration) and 4 tokens



Players: 2 - 4

Rules:

1. The GUESS-A-GRAM cards are shuffled and placed face down in the center of the game board.
   Each player chooses a colored token and places it at the beginning of the road to HOME.

2. The first player picks a GUESS-A-GRAM card and estimates the weight of the object on the card. He/she writes an estimate on his/her paper and passes the object to the person on the left. Play moves clockwise.

3. Each player, in turn, estimates the weight of the object. Then the object is weighed on the scale and the person whose estimate came closest to the actual weight moves ahead one space. If 2 guesses are equally close, both players move ahead 1 space.

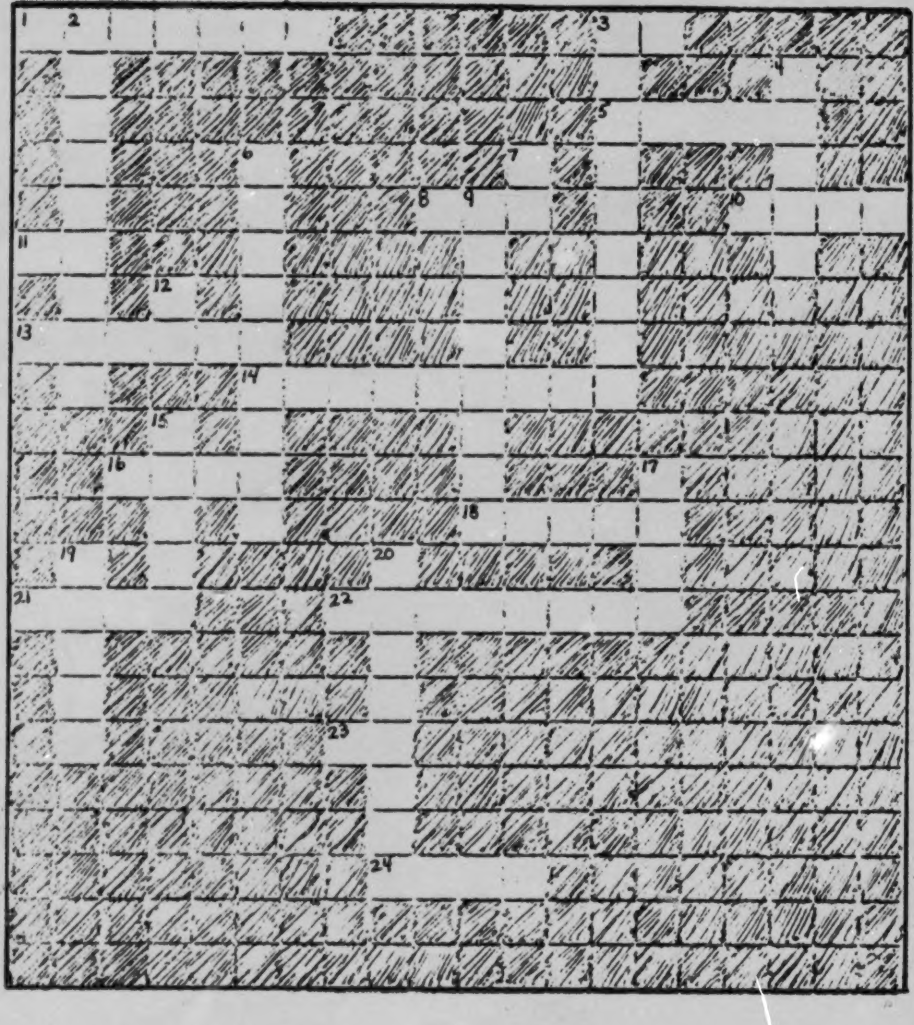
4. The next player then picks a card and is first to estimate the weight of the object on the card. The weight of the object is then estimated by each of the other players.

5. When a card says CHOICE the player can choose any object in the room for the group to estimate.

6. The first player to reach HOME is the winner.

METRIC MASS CROSSWORD PUZZLE

(Module 4)



ACROSS

1. A gram is _____ than a pound.
3. Abbreviation for hectogram.
5. Prefix meaning hundreth.
8. Abbreviation for dekagram.
10. Prefix meaning ten.
11. Abbreviation for kilogram.
13. A pound is _____ than a gram.
14. .01 grams.
16. Prefix meaning tenth.
18. Standard metric unit of length.
21. Prefix meaning thousand.
22. 10 grams.
23. Abbreviation for centigram.
24. A gram is a unit of ______.

DOWN

2. .001 grams.
3. 100 grams.
4. Standard metric unit of volume.
6. Common object with a mass of 1 gram (2 words)
7. Abbreviation for milligram.
9. 1000 grams.
12. Abbreviation for decigram.
15. Prefix meaning hundred.
17. Standard metric unit of mass.
19. Prefix meaning thousandth.
20. .1 gram.

Learning Center Activity #1 METRIC MASS (Module 4)

EQUIPMENT NEEDED: Regular paper clips, black crayon, large paper clip, pencil, ruler, roll of tape

Weigh the items and record their weights below:

1. Five small paper clips weigh ______. 1.____________________grams

2. The black crayon weighs ______. 2.____________________grams

3. The pencil weighs ______. 3.____________________grams

4. The large paper clip weighs ______. 4.____________________grams

5. The ruler weighs ______. 5.____________________grams

6. The roll of tape weighs ______. 6.____________________grams

7. Choose other objects from the room, each of which weighs about 50 grams. List the objects you found. 7.________________________

____

____

____

____

Learning Center Activity #2 METRIC MASS (Module 4)

EQUIPMENT NEEDED: A variety of objects weighing 10 gr, 100 gr and 1,000 gr.

Find objects in the room (or in your purse or pocket) which weigh the following metric mass units. List the objects or group of objects in the column at the right.

1. I've found these objects to weigh about 10 grams:

1a.________________________

1b.________________________

1c.________________________

1d.________________________

2. I've found these objects to weigh about 100 grams:

2a.________________________

2b.________________________

2c.________________________

2d.________________________

3. I've found these objects to weigh about 1 kilogram:

3a.________________________

3b.________________________

3c.________________________

3d.________________________

4. The object in the room weighing closest to one kilogram is:

4a.________________________

(Module 4)

METRIC MASS - POSTTEST

1. What is the basic unit of mass in the metric system? 1. ____________
2. A pound is (heavier/lighter) than a gram. 2. ____________
3. 10 ____________ = 1 dekagram 3. ____________
4. 100 grams = 1 ____________ 4. ____________
5. 100 ____________ = 1 gram 5. ____________
6. 1,000 grams = 1 ____________ 6. ____________
7. 1 gram = ____________ milligrams 7. ____________
8. 1 gram = 10 ____________ 8. ____________

Put the correct letter from the column on the right in front of the word on the left.

____________ 9. centigram
____________ 10. dekagram
____________ 11. milligram
____________ 12. hectogram
____________ 13. gram
____________ 14. kilogram
____________ 15. decigram

a. hg
b. kg
c. dg
d. ml
e. dkg
f. hl
g. cg
h. mg
i. dkm
j. g

Objectives

The participant will be able to:

1. identify and describe the metric temperature measuring scale (Celsius).
2. accurately measure a variety of temperatures using the metric scale.
3. identify commonly occurring temperatures on the Celsius scale.

Suggested Activities to Meet Objectives

1. Study handout on "Measuring Temperature in Metric Units."
2. Study handout on "Celsius and Fahrenheit Temperature Scales."
3. Complete Learning Activity #1, "Metric Temperature."
4. Complete Learning Activity #2, "Metric Temperature."
5. Complete "Temperature Puzzle."
6. Complete Worksheet, "What's the Temperature?"

Illustration of Mastery

1. Agreement of satisfactory between instructor and participant on completion of:
    a. "Metric Temperature" Learning Activity #1.
    b. "Metric Temperature" Learning Activity #2.
2. Completion of "Metric Temperature Posttest" with 80% accuracy.

MEASURING TEMPERATURE IN METRIC UNITS (Module 5)

In countries where metric measurement is used, temperature is also measured in a system that divides the scale into 100 convenient degrees. This is called Celsius temperature and originally was called centigrade. It is named after the man who designed the scale.

The 100 degrees in the Celsius scale are measured between the freezing point and boiling point of water. Thus we already have two "benchmarks" on the scale--at 0^{o}C., water freezes, at 100^{o}C., water boils. In North America, we live and perform most activity between 0^{o} and 30^{o}C. Our outdoor temperature extremes are about -20^{o} to 40^{o}C.

Let's look at some other benchmarks on the Celsius scale that will help you to know whether a metric temperature is hot or cold. A good one to remember is 20^{o}C., which scientists call standard room temperature for comparing various materials that expand or shrink as temperature changes. Twenty degrees Celsius is equal to 68^{o}F. You might want to think of 20^{o}C. as the "comfort line." The human body begins to feel chilled below 20^{o}C. and is comfortable for about 10 degrees above 20^{o}C. Another temperature benchmark is 37^{o}C. which is normal human body temperature.

Our cold weather temperatures are based on zero degrees Fahrenheit which is -17^{o}C. When you talk about subzero weather in Celsius reading, you are talking about the temperatures where flowers and garden plants may be permanently killed, and people begin to suffer some discomfort.

At -20^{o} C. people are in danger of getting frostbite on exposed body parts such as ears, face, and hands. At -30^{o} C. temperature gets into the range of the coldest weather in the United States. At -40^{o}C. mercury becomes a solid. This is also the same temperature as -40^{o} on the Fahrenheit scale. Some observable benchmarks on the Celsius temperature scale are given in Figure 1. A Fahrenheit scale is also included for your information.

In very precise temperature measurements, degrees are divided into tenths or hundredths but there are no special names for these units as there are in length, volume and mass measure.

Metric temperature is sometimes recorded on the absolute or Kelvin scale (K) which has the same size degrees as the C. scale. The lowest point of the scale is 0^{o}K. where most movement of matter stops. Water changes to ice at 273^{o}K. or 0^{o}C.

D. Sorenson

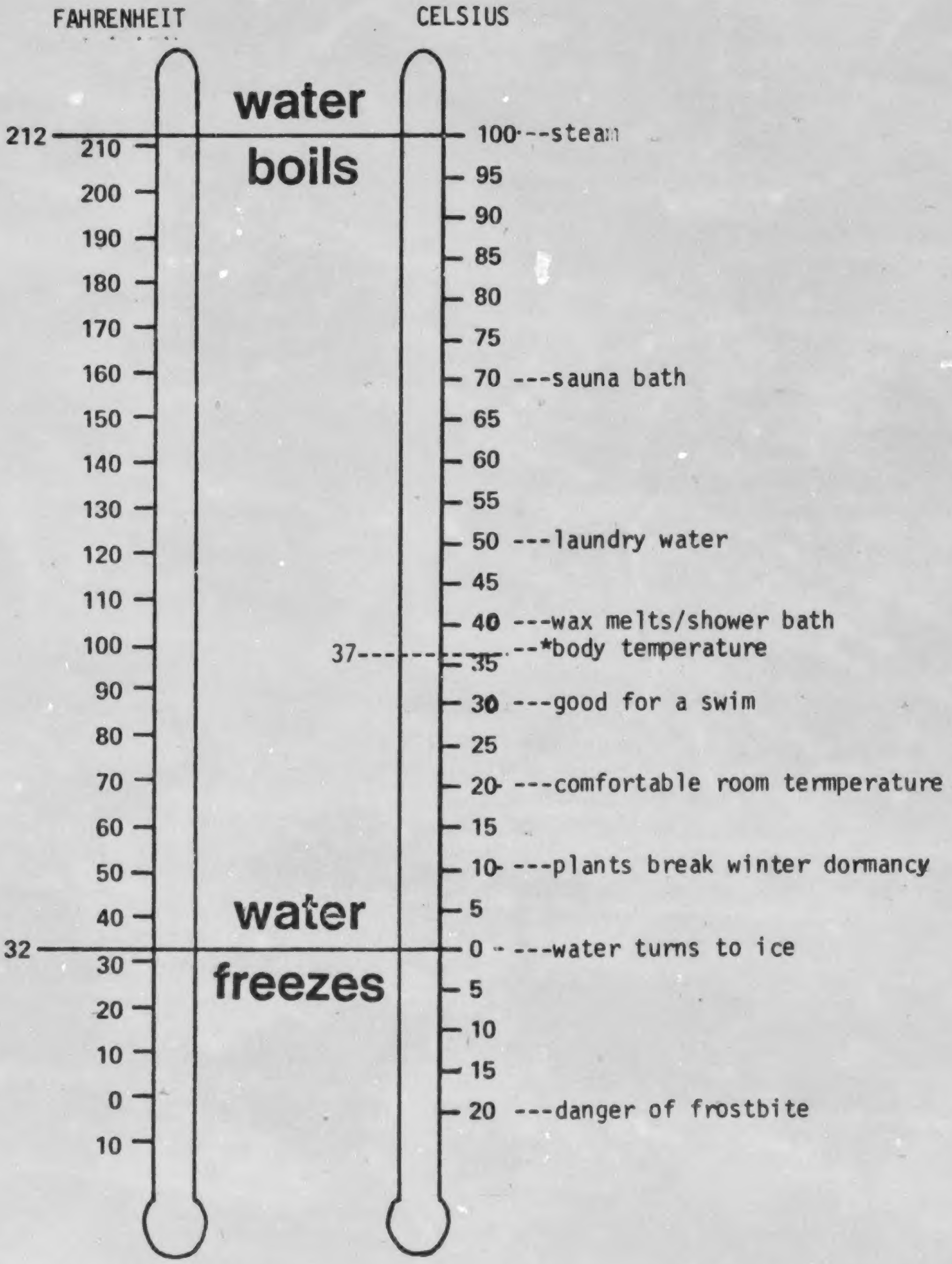

FAHRENHEIT
CELSIUS
water
boils
100---steam
70 ---sauna bath
50 ---laundry water
40 ---wax melts/shower bath
37-----------*body temperature
30 ---good for a swim
20 ---comfortable room termperature
10 ---plants break winter dormancy
0 ---water turns to ice
20 ---danger of frostbite
water
freezes

Figure 1

CELSIUS AND FAHRENHEIT TEMPERATURE SCALES (Module 5)

The scale used for measuring temperature in the United States is called the Fahrenheit scale. It was named after Gabriel Fahrenheit, who devised it in 1706.

In the Fahrenheit scale the temperature of boiling water is numbered 212° F. The temperature of melting ice is 32° F. These two temperatures are called the fixed points. There are 180 degrees between the fixed points of the Fahrenheit scale.

Scientists prefer the Celsius scale, devised by Anders Celsius in 1742. The Celsius scale is used in most countries of the world. It is based on the same fixed points--the boiling point of water and the freezing point of water. But they are given different numbers, 100° C. and 0° C., respectively. There are 100 degrees between the fixed points of the Celsius scale. This scale is sometimes called centigrade. The "cent" part of centigrade means one hundredth, just as one cent is one hundredth part of a dollar.

It is easy to convert from one scale to another by using the following formulas:

Fahrenheit to Celsius	Celsius to Fahrenheit
$C = \frac{5(F - 32)}{9}$	$F = \frac{9}{5}C + 32$

Remember to estimate your answer before you calculate so you will know whether or not your answer is reasonable.

On either scale the numbers refer to the same thing, the motion of the molecules. At 100° C. the molecules of a substance are vibrating faster than at 0° C. But even at 0° C. the molecules are vibrating. So we have to use numbers below zero to describe still slower vibrations, and thus still lower temperatures.

Colder and slower, still colder and slower--is there a temperature at which molecules nearly stop vibrating altogether? There is and it is called absolute zero. It is about 459 degrees below the zero on the Fahrenheit scale. It is 273 degrees below the zero of the Celsius scale.

Adapted from Science in Our World, Heath Company, Level 5.

Learning Activity #1 METRIC TEMPERATURE (Module 5)

Fill a container with very hot water. Measure the temperature with a Celsius thermometer and record it on the chart below. Continue measuring the temperature at three (3) minute intervals until the readings stay the same.

TIME	TEMPERATURE
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

*OPTIONAL: Graph your results with the Celsius thermometer
*OPTIONAL: Take the temperature readings in both Celsius and Fahrenheit degrees. Chart (on the above table) and graph the results from both scales. Compare your results.

---

* Adapted from Individualized Science, Lagrange Student Activity #13.

METRIC TEMPERATURE

Find a thermometer with both Celsuis and Fahrenheit scales on it (or use separate Celsius and Fahrenheit thermometers.) Record the outside temperature for a week or longer. Make your measurements at about the same time each day and in the same location. (For example, outside the back door, outside the window, etc.) Chart your findings below.

DATE	TIME	TEMPERATURE C°	TEMPERATURE F°
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

*Adapted from Individualized Science, Lagrange Student Activity #7

TEMPERATURE PUZZLE (Module 5)

Solve the following problems. Write the correct answers on the blanks at the right. Notice that the letters under each blank are part of the code for solving the puzzles at the end of the problems. The first problem is completed for you.

1. The average summer temperature for the Great Lakes is 18°Celsius. The average temperature of the Gulf of Mexico is 29°Celsius. What is the difference in average temperature for the two bodies of water?

   11 °C
   A

2. Find the average temperature for five lakes in Pasco County on a given day when the temperatures were 30°C, 28°C, 32°C, 29°C, and 31°C.

   ____ °C
   N

3. A certain candy recipe calls for cooking the mixture until the temperature reaches 120°C. If Jean has the mixture at 87°C now, how many degrees must the temperature increase?

   ____ °C
   B

4. If it took 3 hours for a 3 kilogram beef roast to increase its temperature from 1°C to 85°C, what was the average number of degrees the temperature rose per hour?

   ____ °C
   R

5. Normal body temperature is 37°C. Normal room temperature is about 22°C. How many degrees warmer is your body than normal room temperature?

   ____ °C
   D

6. The boiling point of water is 100°C. Alcohol boils at 78°C. How many degrees difference is there in their boiling points?

   ____ °C
   L

7. One week in June, New York City had the following temperatures: 25°C, 27°C, 29°C, 22°C, 24°C, 28°C, and 27°C. Find the average temperature for that June week.

   ____ °C
   S

8. One chilly winter day the temperature dropped from 5°C to -8°C. How many degrees did the temperature fall?

   ____ °C
   I

9. While Carol was helping her mother cook dinner, she noticed the meat loaf recipe called for an oven temperature of 220°C. If the oven had already heated to 41°C, how many degrees must it still increase?

   ____ °C
   W M G

Adapted from Amusements in Developing Metric Skills, p. 36-37.
UW-EC, 1975

Temperature Puzzle (cont.)

10. A chocolate chip cookie recipe calls for a baking temperature of 190°C. If the oven overheated 55°C, what would its temperature be?

________ °C
U C E

11. During a hot month in Dodge City the noon daily temperatures averaged 12°C above normal. What was the total number of degrees above normal for those 30 days?

________ °C
T H

12. One winter day when the temperature was 22°C in Hawaii, it was -22°C in Alaska. What was their temperature difference?

________ °C
F

13. How many Celsius degrees are there between the boiling point and freezing point of water?

________ °C
V

14. How many Celsius degrees are there between the boiling point of water and normal body temperature?

________ °C
K

Complete the puzzles below by filling in the letter which corresponds to the number under each blank. The numbers are the answers to the problems above, and the letters are those which are listed under the answer blanks. As an example, 11 is the code for A; an A has been written in each blank where the number 11 appears.

English physicist and mathematician who devised a scale of temperature:

$\overline{1}\ \overline{13}\ \overline{22}\ \overline{22}\ \overline{13}\ \overset{\text{A}}{\overline{11}}\ \overline{7} \qquad \overline{6}\ \overline{5}\ \overline{22}\ \overline{10}\ \overline{13}\ \overline{30}$

Swedish astronomer who devised a temperature scale:

$\overset{\text{A}}{\overline{11}}\ \overline{30}\ \overline{15}\ \overline{5}\ \overline{8}\ \overline{26} \qquad \overline{4}\ \overline{5}\ \overline{22}\ \overline{26}\ \overline{13}\ \overline{2}\ \overline{26}$

German physicist who devised a temperature scale and introduced the use of mercury in thermometers:

$\overline{9}\ \overset{\text{A}}{\overline{11}}\ \overline{33}\ \overline{8}\ \overline{13}\ \overline{5}\ \overline{22} \qquad \overline{44}\ \overset{\text{A}}{\overline{11}}\ \overline{60}\ \overline{8}\ \overline{5}\ \overline{30}\ \overline{60}\ \overline{5}\ \overline{13}\ \overline{3}$

ANSWER KEY

TEMPERATURE PUZZLE

(Module 5)

1. The average summer temperature for the Great Lakes is 18 Celsius. The average temperature of the Gulf of Mexico is 29 Celsius. What is the difference in average temperature for the two bodies of water? $\underset{A}{\underline{11}}$ C

2. Find the average temperature for five lakes in Pasco County on a given day when the temperatures were 30°C, 28°C, 32°C, 29°C, and 31°C. $\underset{N}{\underline{30}}$ C

3. A certain candy recipe calls for cooking the mixture until the temperature reaches 120°C. If Jean has the mixture at 87°C now, how many degrees must the temperature increase? $\underset{B}{\underline{33}}$ C

4. If it took 3 hours for a 3 kilogram beef roast to increase its temperature from 1°C to 85°C, what was the average number of degrees the temperature rose per hour? $\underset{R}{\underline{28}}$ C

5. Normal body temperature is 37°C. Normal room temperature is about 22°C. How many degrees warmer is your body than normal room temperature? $\underset{D}{\underline{15}}$ C

6. The boiling point of water is 100°C. Alcohol boils at 78°C. How many degrees difference is there in their boiling points? $\underset{L}{\underline{22}}$ C

7. One week in June, New York City had the following temperatures: 25°C, 27°C, 29°C, 22°C, 24°C, 28°C, and 27°C. Find the average temperature for that June week. $\underset{S}{\underline{26}}$ C

8. One chilly winter day the temperature dropped from 5°C to -8°C. How many degrees did the temperature fall? $\underset{I}{\underline{13}}$ C

9. While Carol was helping her mother cook dinner, she noticed the meat loaf recipe called for an oven temperature of 220°C. If the oven had already heated to 41°C, how many degrees must it still increase? $\underset{W\ H\ G}{\underline{179}}$ C

10. A chocolate chip cookie recipe calls for a baking temperature of 190°C. If the oven overheated 55°C, what would its temperature be? $\underset{U\ C\ E}{\underline{245}}$ C

11. During a hot month in Dodge City the noon daily temperatures averaged 12°C above normal. What was the total number of degrees above normal for those 30 days? $\underset{T\ H}{\underline{360}}$ C

Adapted from Amusements in Developing Metric Skills, p. 36-37.
UW-EC, 1975

Answer Key - Temperature Puzzle (cont.)

12. One winter day when the temperature was 22°C in Hawaii, it was -22°C in Alaska. What was their temperature difference?
44° C
F

13. How many Celsius degrees are there between the boiling point and freezing point of water?
100° C
V

14. How many Celsius degrees are there between the boiling point of water and normal body temperature?
63° C
K

Complete the puzzles below by filling in the letter which corresponds to the number under each blank. The numbers are the answers to the problems above, and the letters are those which are listed under the answer blanks. As an example, 11 is the code for A; an A has been written in each blank where the number 11 appears.

English physicist and mathematician who devised a scale of temperature:

W I L L I A M K E L V I N
1 13 22 22 13 11 7 6 5 22 10 13 30

Swedish astronomer who devised a temperature scale:

A N D E R S C E L S I U S
11 30 15 5 8 26 4 5 22 26 13 2 26

German physicist who devised a temperature scale and introduced the use of mercury in thermometers:

G A B R I E L F A H R E N H E I T
9 11 38 8 13 5 22 44 11 60 8 5 30 60 5 13 3

WHAT'S THE TEMPERATURE? *

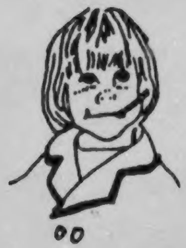
(Module 5)

Directions:

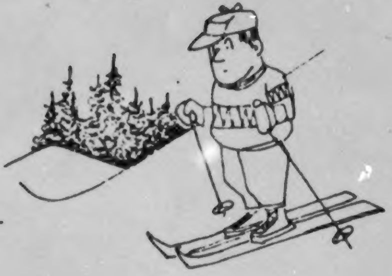
Record the correct temperature from the list below in the blank beside the picture.

0° Celsius
100° Celsius
37° Celsius
60° Celsius
-40° Celsius
80° Celsius
20° Celsius
30° Celsius
-10° Celsius
-30° Celsius

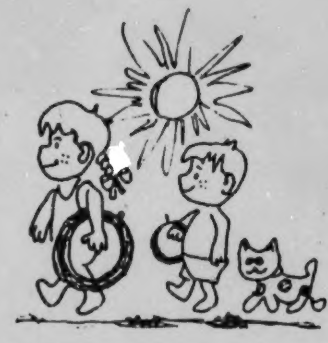
1 ______________



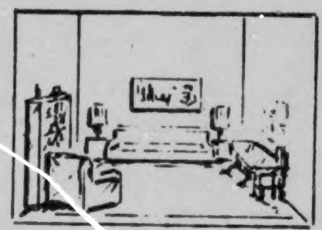
2. ______________



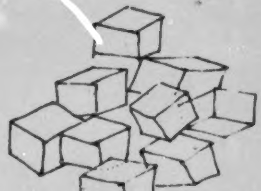
3. ______________



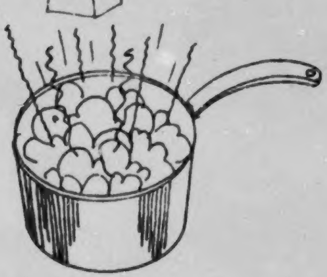
4. ______________



5. ______________



6. ______________



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* Adapted from Metric Exercises, p. 16

METRIC TEMPERATURE - POSTTEST (Module 5)

Directions: Choose the best answer for each item.

1. A typical temperature for a July day in New York City is

   a) 31° C
   b) 90° C
   c) -5° C

2. A typical temperature for a January day in New York City is

   a) 30° C
   b) 90° C
   c) -5° C

3. A person with a fever might have a temperature of

   a) 38.3° C
   b) 78.2° C
   c) 12.5° C

4. A cake is baked at a temperature of

   a) 17° C
   b) 177° C
   c) 347° C

5. A freezer has a temperature of

   a) -18° C
   b) 18° C
   c) 25° C

6. An air conditioner is set to maintain

   a) 22° C
   b) 52° C
   c) 70° C

7. An average high temperature for Los Angeles in April is

   a) 62° C
   b) 21° C
   c) 89° C

Adapted from Amusements in Developing Metric Skills, p. 39

8. **The boiling point of water is**

   a) 100° C
   b) 212° C
   c) 300° C

9. The freezing point of water is

   a) 30° C
   b) 15° C
   c) 0° C

10. Absolute Zero is

    a) 0° C
    b) -273° C
    c) -500° C

Objectives

The participant will be able to:

1. convert from one set of metric units to another using the six basic prefixes and applying them to measurement of length, volume and mass.
2. convert among units of length, volume and mass (using water at 4^{o} C. as a standard).

Suggested Activities to Meet Objectives

1. Read and study "Relationships Within the Metric System."
2. Complete Discussion/Demonstration "Concepts Within the Metric System."
3. Complete worksheet, "Time for Breakfast."
4. Complete Learning Center Activity #1.
5. Work crossword puzzle, METRIC CONVERSIONS
6. Work measurement puzzles: LENGTH, VOLUME, MASS. Complete practice puzzle page 91 before working measurement puzzle.
7. Play Metric Bingo

Illustration of Mastery

1. Completion of "Conversions" posttest with 80 percent accuracy.
2. Agreement of "satisfactory" between participant and instructor on:
   a. Worksheet, "Time for Breakfast."
   b. Learning Activity #1.

When you have learned the basic metric units of length, volume and mass, you have the basis for every measurement needed in everyday living and in special kinds of work.

Other measuring units are derived from the three basic units and are all interrelated within the metric system. The nicest thing is that they all have simple relationships to each other. They are multiples of 10, 100, or 1,000--the same as in length, mass and volume. This makes calculations extremely simple, requiring only that you move a decimal point to multiply or divide. Mental calculations are easy to do for many relationships, too.

Let's see what these relationships are within the metric system.

Interrelationships of Length

As soon as you learn metric length, you can measure metric area, which is length x width. The meter is the basic length unit, and the square meter is the basic area unit. A square meter is a little bigger than a square yard. Small areas are usually measured by the square centimeter (about ½ the area of a postage stamp).

For larger areas, such as land measurement, the common measurement is a square 100 meters on each side or 10,000 square meters. This area unit is called the hectare. You can remember its dimensions because of the hecto-prefix, which means 100. A hectare is about the size of 2½ football fields.

Very large land areas are measured in square kilometers. A square kilometer is 1,000,000 square meters. It is also 100 hectares.

Do you notice how easy it is to divide area into smaller units? A square kilometer divided by 1000 equals 100 hectares. A hectare divided by 100 equals a square meter. A square meter divided by 10,000 equals a square centimeter. You can divide or multiply simply by moving the decimal point.

Interrelationships Between Length and Volume

You will recall that we previously said the liter was the basic metric volume unit. The liter is derived from a length unit, too. It works like this. If you take a box 10 centimeters long by 10 centimeters wide by 10 centimeters high, you will have a unit that has a volume of 1,000 cubic centimeters. Or 1,000 cubic centimeters is also equal to a cubic decimeter (1 decimeter by 1 decimeter by 1 decimeter). The liter or cubic decimeter is slightly larger than a quart, and convenient for everyday use.

When we want to measure very small volumes, we use cubic centimeters. A cubic centimeter (1 cm long by 1 cm wide by 1 cm high) is equal to 1/1000 of a liter. We call this a milliliter. You will recall that we used this term, too, in earlier study of metric volume. A small sugar cube is slightly bigger than a cubic centimeter.

If we want to measure very large volumes of solid materials such as coal. iron, gravel, cement and soil, we use a larger unit called the cubic meter, which measures 1 meter by 1 meter by 1 meter. A cubic meter is slightly larger than the cubic yard that is in common use in the United States. It equals about 30 bushels.

Interrelationships Between Mass and Volume

Remember that the basic units of mass are the gram and the kilogram (1000 grams). There is an interesting and useful relationship between the volume and mass when we use water at 4° C. as a standard. Let's explore this relationship.

One kilogram (1000 grams) of water occupies a volume of 1000 cubic centimeters or 1 liter. Therefore, it follows that 1 gram of water has a volume of 1 cubic centimeter and 1000 kilograms of water have a volume of 1 cubic meter.

Very large quantities of material are measured by the metric ton, which is 1000 kilograms. One metric ton of water (4° C.) has a volume of one cubic meter.

Interrelationships Among Length, Volume and Mass

In the preceding sections we have discussed the interrelationships between two of the basic measuring units at a time. Perhaps many of you have already figured out that since both length and mass are interrelated to volume, the three basic units have to be interrelated to each other.

One way you can figure this out is illustrated in Figure 1. The equipment used includes a liter beaker, a container 1 decimeter x 1 decimeter x 1 decimeter, and balance. When the liter beaker filled with water is poured into the 1 cubic decimeter container, it fills it exactly. When the cubic decimeter container is weighed on the scale, it is balanced by a 1 kilogram mass (the weight of the container must be compensated for).

Thus we found that the contents of the liter exactly fit in the cubic decimeter container. This shows that these two units (the liter and cubic decimeter) are equal for water at 4° C. We also found that the cubic decimeter container of water was balanced by 1 kilogram of mass. That shows that these two units, the cubic decimeter and kilogram, are equal.

In other words: 1 liter = 1 cubic decimeter = 1 kilogram. Therefore 1/1000 of a liter (1 milliliter) = 1/1000 cubic decimeter (1 cubic centimeter) = 1/1000 of a kilogram (1 gram). When you measure in one of the units--length, volume or mass--you automatically have the other two. Remember this exact equality relates only to water at 4° C. If you use other liquids than water, they will occupy the same volumes (liter and cubic decimeter) but will have a different mass. Do you have any idea why?

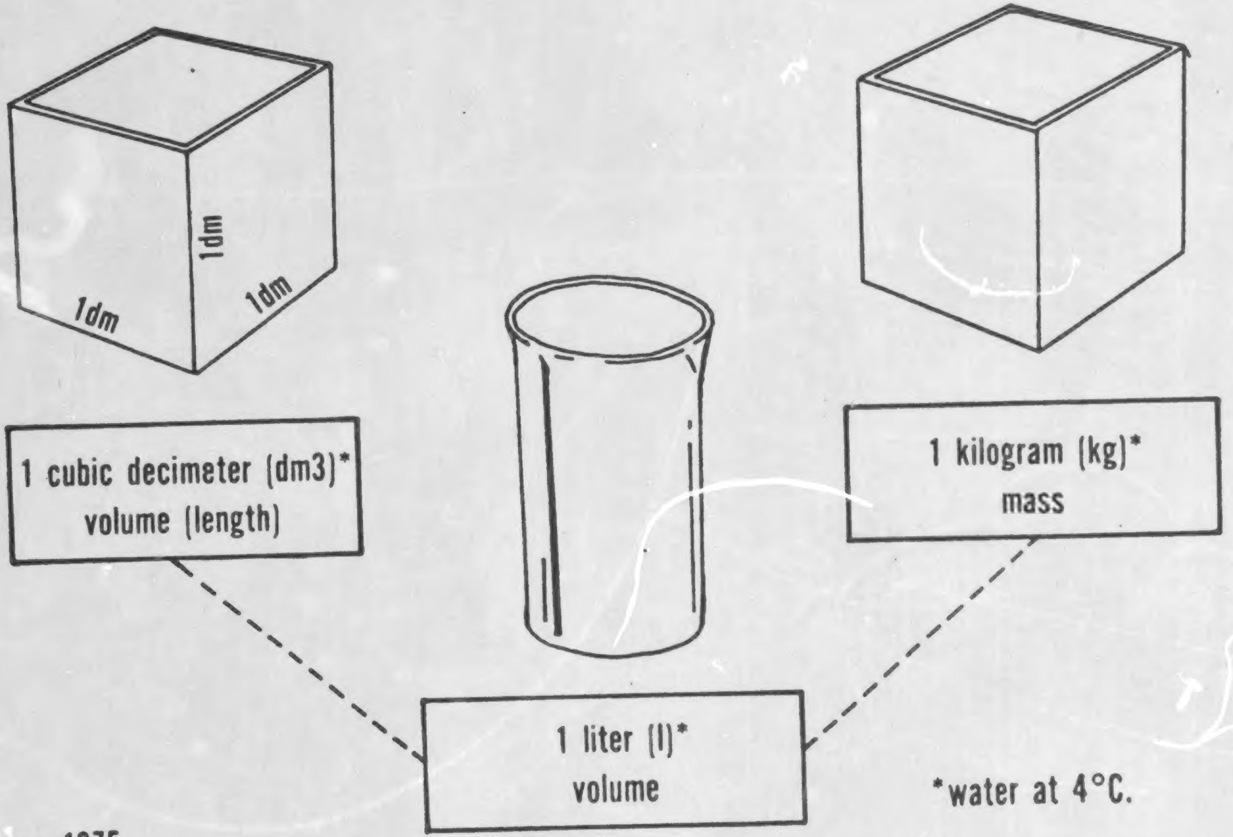
There are many more relationships of units within the metric system when you measure power, light, work, electricity and other energy units. You can learn these terms as you need them in various specialized areas. But you will always find that they have convenient conversions from one unit to another. They will be multiples of 10, 100, 1,000 or even 1,000,000 which are easily calculated by merely moving a decimal point. They will have the same prefixes of milli-, centi-, deci-, deka-, hecto-, and kilo- for identification of their size.

The convenient relationships within the metric system are what make it the most efficient and understandable measuring system in the world.

Here are the convenient symbols for the units of area, volume and mass that we have been discussing:

Area	Symbol	Volume	Symbol	Mass	Symbol
square centimeter	cm^2	cubic centimeter	cm^3	gram	g
square decimeter	dm^2	milliliter	ml	kilogram	kg
square meter	m^2	cubic decimeter	dm^3	metric ton	t
hectare	ha	liter	l		
square kilometer	km^2	cubic meter	m^3		

RELATIONSHIPS: LENGTH, MASS, VOLUME



1 cubic decimeter (dm3)*
volume (length)

1 kilogram (kg)*
mass

1 liter (l)*
volume

*water at 4°C.

Sorenson, 1975

CONCEPTS WITHIN THE METRIC SYSTEM

(This session would be led by an instructor.)

1. Review prefixes used in the metric system.
    a. Relate them to the meter, liter and gram.
    b. Relate the prefixes to each other.
        1. Have participants fill in the chart, "Relationships Among Metric Prefixes."
        2. Discuss the patterns seen in the chart.
2. Compare the relationships among the units of the metric system.
    a. Review (or explain) the concept of area ($l \times w = a \left[x^2\right]$).
    b. Review volume ($l \times w \times h = v \left[x^3\right]$) (transparency).
    c. Review the metric unit, liter, as a unit of volume.
3. Demonstrate the relationship between the liter and cubic decimeter.
    a. Use 2 containers, a 1 liter cylinder and a cubic decimeter container.
    b. Fill the cubic decimeter with exactly one liter of water.
    c. Carefully pour the water from the cubic decimeter into the 1 liter cylinder.
    d. Is there more water in the liter or the cubic decimeter?

    CONCLUSION: One cubic decimeter = one liter
4. Discuss when to use volume in cubic units and volume in liters.
    a. Liquids are measured in liters.
    b. Solids are measured in cubic meters or cubic centimeters.
    c. The teacher gives examples of items measured by volume; the students respond with the type of volume measurement the item is expressed in. (e.g. cubic meters, cubic centimeters, or liters)

    CONCLUSION: Liquids are measured in liters and solids in cubic meters or centimeters.

5. Demonstrate the relationship between length and volume and mass in the metric system.

   a. Weigh the empty cubic decimeter container.

   b. Fill the container with water(4° C).

   c. Weigh the decimeter container filled with water. (Be sure to compensate for the weight of the container.)

   d. How much does the water weigh?

   e. Complete the equation: 1 dm^3 = 1 liter = ___________ (mass)

   CONCLUSION: 1 dm^3 = 1 liter = 1 kg

6. Discuss the relationship between the cubic centimeter, the milliliter and the gram using water at 4° C as a standard.

   a. If 1 liter of water weighs 1 kilogram, then .001 liter of water would weigh .001 kilogram or 1 gram.

   b. Complete the equation: 1 cm^3 = 1 ml = ___________

   CONCLUSION: 1 cm^3 = 1 ml = 1 g.

7. Complete the chart, "Relationships Among Metric Prefixes" on page 82.

RELATIONSHIPS AMONG METRIC PREFIXES

(Module 6)

*	km	hm	dkm	m	dm	cm	mm
km	*						
hm		*					
dkm			*				
m				*			
dm					*		
cm						*	
mm							*

Answer Key RELATIONSHIPS AMONG METRIC PREFIXES (Module 6)

*	km	hm	dkm	m	dm	cm	mm
km	*	10	100	1,000	10,000	100,000	1,000,000
hm	.1	*	10	100	1,000	10,000	100,000
dkm	.01	.1	*	10	100	1,000	10,000
m	.001	.01	.1	*	10	100	1,000
dm	.0001	.001	.01	.1	*	10	100
cm	.00001	.0001	.001	.01	.1	*	10
mm	.000001	.00001	.0001	.001	.01	.1	*

Worksheet TIME FOR BREAKFAST (Module 6)

As a shopper, you probably like to "get the most for your money." Decide which amount of each item below is the largest. Write the letter for the "best buy" in the blank at the right.

1. Breakfast food is about 49¢ for: 1.__________

a. 500 grams
b. .49 kilograms
c. 60 dekagrams

2. Milk is about 55¢ for: 2.__________

a. 20 deciliters
b. .2 liters
c. 200 milliliters

3. A loaf of bread is about 45¢ for: 3.__________

a. .75 kilograms
b. 7.5 dekagrams
c. 700 grams

4. Butter is about 85¢ for: 4.__________

a. .45 kilograms
b. 50 grams
c. 47 dekagrams

5. Jam is about 69¢ for: 5.__________

a. 170 grams
b. .18 kilograms
c. 15 dekagrams

6. Peanut butter is about 96¢ for: 6.__________

a. .70 kilograms
b. 5000 centigrams
c. 750 grams

7. Bacon is about $1.19 for: 7.__________

a. 50 grams
b. 5 hectograms
c. 4.5 dekagrams

Sorenson/Kluever

Time for Breakfast - 2

8. Orange juice is about 39¢ for: 8.____________

   a. 10 deciliters
   b. 1.2 liters
   c. 1000 milliliters

9. Coffee is about $3.50 for: 9.____________

   a. 1.5 kilograms
   b. 14 hectograms
   c. 1500 decigrams

10. Breakfast sausage is about $1.90 for: 10.____________

   a. 89 dekagrams
   b. .95 hectograms
   c. 900 grams

Learning Center Activity #1 METRIC AREA (Module 6)

EQUIPMENT NEEDED: scissors, tape, meter stick, cm^2 grid paper

1. Look at your sheet of grid paper. This used to be identified as 8½ x 11 inches. Estimate its dimensions in metric. (Grid paper on page 87) 1. _____ x _____

2. Cut out a rectangle (BUT NOT A SQUARE) with an area of 100 cm^2.
   a. Record its area. 2a. ________________

   b. What is the perimeter? 2b. ________________

3. Cut your rectangle (from 2 above) into pieces to make a square decimeter. Tape it together.
   a. Record its area. 3a. ________________

   b. Record its perimeter. 3b. ________________

4. Use your square decimeter to estimate and measure the area of 3 surfaces around the room (e.g., books, desks, tables). Record the measurements.

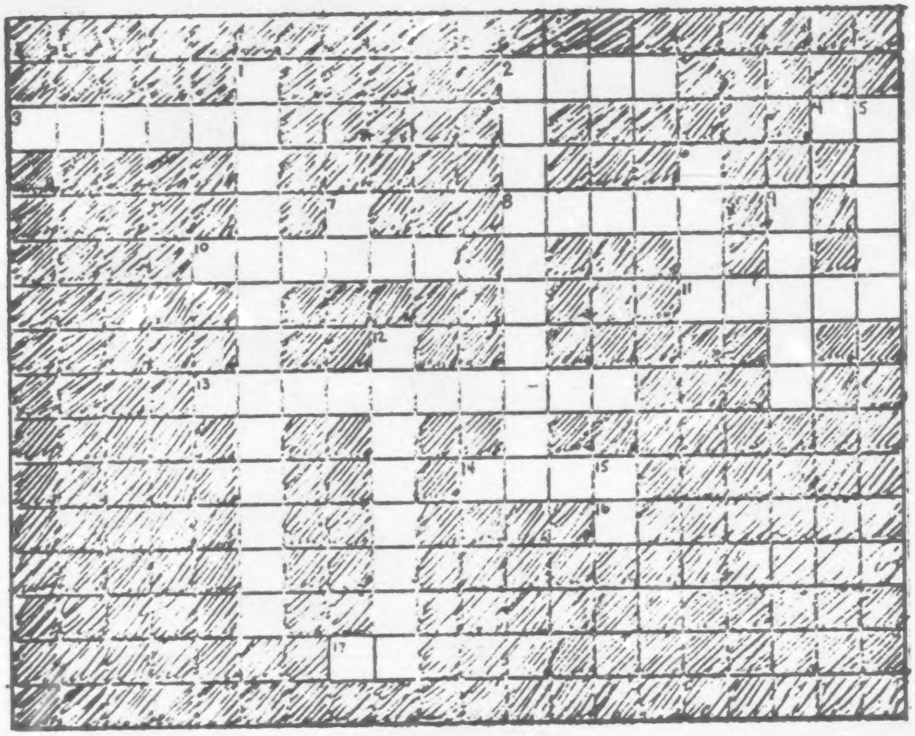
	Article	Estimate	Measurement
a.			
b.			
c.			

5. Take a meter stick. Identify an object in the room which has a surface of about one square meter. What is it? 5. ________________

6. Choose a large surface in or near the room (e.g., windows, chalkboard, screen, floor, door, etc.)
   a. What surface did you choose? 6a. ________________

   b. Measure and record its area. 6b. ________________

METRIC CONVERSIONS CROSSWORD PUZZLE (Module 6)



ACROSS

2. A kilogram is a unit of ____________.
3. A milliliter is a unit of ___________.
4. Symbol for milliliter.
8. Metric unit with largest volume -- milliliter, liter, or centiliter.
9. Symbol for liter is ________________.
10. A meter is a unit of ________________.
11. A __________ stick looks very much like a yardstick.
13. A metric unit of length.
14. Metric unit with least mass -- gram or kilogram?
16. Symbol for meter.
17. Symbol for centimeter.

DOWN

1. °C is a short way to write __________.
2. Shortest metric unit of length -- millimeter, meter or centimeter?
5. Basic metric unit of volume.
6. Basic metric unit of mass.
7. Symbol for kilogram.
9. A quart and a ______ have about the same volume.
12. The metric mass of 2 pounds is about 1 ________.
15. Symbol for millimeter.

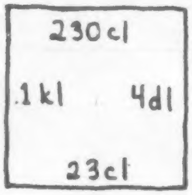
Three puzzles, one each on length, volume and mass, make up this learning activity. For each puzzle, the participant is asked to find the equivalent on each side of each square. The participant is required to complete one of the puzzles, but is encouraged to work all three of them. You may work alone or with someone else. Before starting a puzzle, you are encouraged to complete a "practice puzzle" on length or volume. A description of the practice puzzle on volume is presented below:

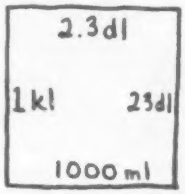
Practice Puzzle: Volume

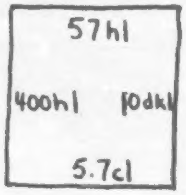
This is a small practice puzzle to use as a warm-up before trying the 16-square ones (length, volume and mass) shown on the following pages.

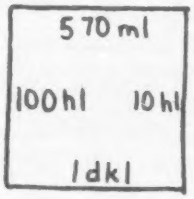
Arrange the four puzzle pieces (shown below) into one large square so that all adjacent sides name equal volumes.

Here are the puzzle pieces:

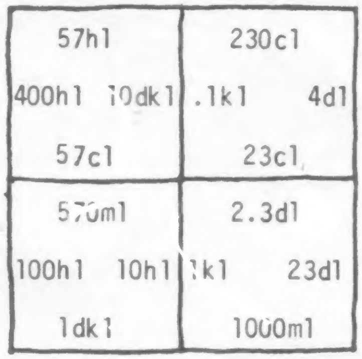

230cl
.1kl
4dl
23cl


2.3dl
1kl
23dl
1000ml


57hl
400hl
10dkl
5.7cl


570ml
100hl
10hl
1dkl

When you've finished, the puzzle pieces should be in this order:


57hl
400hl
10dkl
57cl
230cl
.1kl
4dl
23cl
570ml
100hl
10hl
1dkl
2.3dl
1kl
23dl
1000ml

LENGTH MEASUREMENT PUZZLE

(Module 6)

Cut out the squares. Fit them together so that all adjacent sides name the same lengths.

.057 mm .4 cm .01 mm .023 km	23 m 4 cm 10 dm 57 cm	230 m 400 km 40 hm 57 dm	23 mm 40 m 400 m 5.7 km
570 mm 10 cm .4 mm 230 dkm	57 hm 400 hm 10 dkm .057 cm	57 km .01 m 4 m 23 dkm	230 cm .1 km 4 dm 23 cm
23 hm .04 dkm .04 mm 570 km	570 m 4 km 10 m 2.3 cm	5.7 m .01 mm 400 dm 57 mm	2.3 dm 1 mm 4 mm 57 m
23 km 40 dkm 1 dm 2300 mm	.023 hm 40 dm .1 cm 5.7 hm	5.7 cm .1 mm 40 km 230 km	570 dm 1 dkm 40 mm 230 hm

* Taken from *Amusements in Developing Metric Skills*; Clack & Leitch, p.10.

VOLUME MEASUREMENT PUZZLE

(Module 6)

Cut out the squares. Fit them together so that all adjacent sides name the same volumes.

.56 m^3 3.4 m^3 .034 l 1 ml	.42 ml 340 ml 7 l 56 cm^3	2 m^3 1 cm^3 1 l 42 cm^3	560 ml 60 l 1000 l 2 dm^3
56 ml 2 ml 60 ml .002 l	370 ml 6 l 2000 l 1 m^3	1 cm^3 1 m^3 34 l 2000 l	56 ml 1000 ml 3.4 cm^3 37 l
1000 dm^3 .7 ml 3400 l .56 l	5.6 ml 3.4 ml .6 ml 42 l	37 ml 2000 ml .34 l 1 l	2 cm^3 3400 cm^3 7 ml .0056 l
4.2 l 2 m^3 2 l 560 l	2000 cm^3 70 ml .001 l 3.7 l	5600 ml 34000 ml 3.4 l .056 l	1 dm^3 34 cm^3 2 cm^3 5.6 l

* Taken from Amusements in Developing Metric Skills; Clack& Leitch,p.31.

MASS MEASUREMENT PUZZLE

(Module 6)

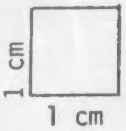
Cut out the squares. Fit them together so that all adjacent sides name the same masses.

690 g 1 mg 300 dg 1.2 cg	.02 mg 10 cg 690 kg 1200 g	12 kg .03 t .01 g .03 mg	1.2 kg 30 g 300 kg 69 dg
1.2 dg .3 kg 1 dg .69 kg	6.9 g .1 kg .069 cg .012 t	120 cg .3 cg .003 t .12 kg	120 g 3 cg 3 g .3 mg
12 mg 3 kg 100 g 6.9 kg	.1 mg .069 mg 10 g 69 cg	6900 g 30 dg 30 kg 12 cg	12 g 69 kg 30 mg 120 kg
6.9 cg .3 g .1 cg 1200 mg	690 dg 10 dg 3 mg .012 kg	690 mg .01 mg 3 dg 69 g	.0012 kg 100 dg 300 g 69 mg

* Taken from Amusements in Developing Metric Skills; Clack & Leitch,p.23.

Learning Center Activity #3 METRIC AREA (Module 6)

Area is the measure of a surface. Area can be dealt with in terms of a one-to-one correspondence with the unit of one square centimeter. You should already be familiar with the length of a centimeter. A square centimeter would be:

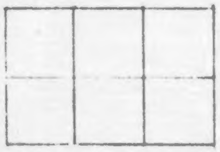


= 1 cm^2

The activities given below are set up so that you can find the area of the figures without knowing the 1 x w = a formula, which requires multiplication. You should be able to make an estimate of the area, then accurately find the area using the a cm ^{2} notation.

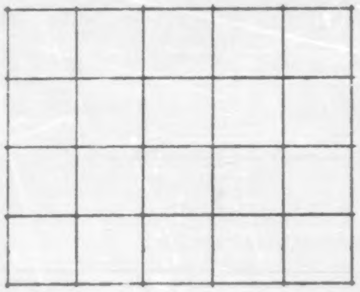
Activity 1: Count the number of square centimeters in the figures below and fill in the blanks. Check the answers.

a.



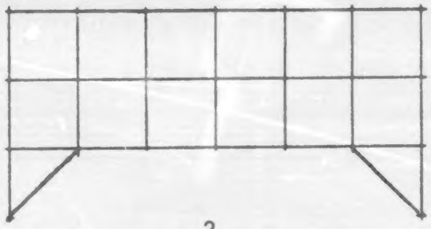
____ cm^2

b.



____ cm^2

c.



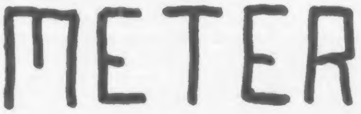
____ cm^2

Activity 2: Cut out figures of the sizes specified below and paste them on a sheet of paper.

a. 20 cm^2 b. 13 cm^2 c. 1 dm^2

Activity 3: Draw around your hand. Estimate the area; now lay the transparent grid over the drawing, and count the number of whole centimeters. Count all parts of a centimeter that are larger than one-half and add them to the total. Total equals ____ cm^2.

Activity 4: Find the area in the word "METER".



Additional Activity: Find the area of the room, playground, etc., in square meters.

METRIC BINGO

Materials: Markers (corn, beans, small paper squares)

Metric Bingo Cards (shown in the example below).

The spaces are randomly filled with symbols for measurements from the list below. Length measurements are placed in the L column, volume under V and mass under M. Square and cubic dimensions are used in the D column.

Two spaces on the card may be used as "free" spaces. They should be in two different columns and be written in red. The appropriate word--length, volume, mass or dimension--is written in each free space (see example).

Calling Cards

Each card names an equivalent of the measurements shown on the Bingo card (see list below). The top of each card is marked L, V, M or D to indicate the column in which the correct answer will be found.

Metric Bingo

L	V	M	D
hm	volume	kg	dm^3
dkm	hl	mass	km^2
cm	dkl	g	m^2
mm	cl	dg	m^3

Symbol	Equivalent
km	1,000 meters
hm	100 meters
dkm	.1 hectometer
m	1,000 millimeters
dm	.01 dekameter
cm	.1 decimeter
mm	.001 meter
kl	10 hectoliters
hl	.1 kiloliters
dkl	100 deciliters
l	100 centiliters
dl	10 centiliters
cl	.1 deciliter
ml	.001 liter

Symbol	Equivalent
kg	1,000 grams
hg	10 dekagrams
dkg	.1 hectogram
g	10 decigrams
dg	10 centigrams
cg	10 milligrams
mg	.001 gram
m^2	100 square decimeters
cm^2	100 square millimeters
cm^3	1,000 cubic millimeters
dm^3	.001 cubic meter
m^3	1,000 cubic decimeters
dm^2	100 square centimeters
km^2	10,000 square hectometers

Players: 2 - 7, plus a caller

Rules:

1. Each player takes one or more Metric Bingo Cards. The spaces in red are free and may be covered before the game begins.

2. The caller shuffles the cards, then reads the top one, naming both the letter which identified the column and the equivalent measurement (e.g., V - .01 liter).

3. The players find the correct equivalent measurement on their cards and cover them.

4. When a player has covered a complete row--across, down, or diagonally--he or she calls out "Bingo." That player then uncovers and reads each of the covered answers while the caller checks to be sure the covered words were correct. If all are correct, the player who called "Bingo" is the winner. If the player has made a mistake, play continues until a winner is found.

RELATIONSHIPS WITHIN THE METRIC SYSTEM - POSTTEST (Module 6)

Metric measurements are given in the first column. In the second column are equivalent measurements. Find an equivalent in the second column to match each measurement in the first column. Put the correct letter in the blank at the left.

_______ 1) 250 dl
_______ 2) 2.5 g
_______ 3) .5 g
_______ 4) 500 dkg
_______ 5) 25 mg
_______ 6) 2.5 l
_______ 7) 50 hl
_______ 8) 50 m
_______ 9) 500 cm
_______ 10) 2.5 hm

a) .05 kilometers
b) 50 hectograms
c) 2.5 dekaliters
d) 250 meters
e) 5 kiloliters
f) 50 hectometers
g) 25 decigrams
h) 250 centiliters
i) 50 decimeters
j) 2.5 centigrams
k) 500 milligrams
l) 50 milliliters

The following items relate to water at 4° C.

_______ 11) What is the volume in liters of a dm^3?
_______ 12) What is the mass of a ml?
_______ 13) What is the volume in cubic units of a kg?
_______ 14) What is the volume in liters of a kg?
_______ 15) What is the volume in cubic units of a g?

Objectives

The participant will be able to:

1. indicate instances of metric measurement in everyday life.
2. complete a story, activity or other project in which metric measurement is used.

Suggested Activities to Meet Objectives

1. Collect can labels from supermarket items which have metric and English units on them. Make a chart and list metric and English units, along with a description of the item. (See Learning Activity #1) When you've finished, make a collage from the can labels for display in the classroom area.
2. Use a metric roadmap and plan a vacation route for you and your family. Mark some things you would like to visit and the distances (in kilometers) between them. (Roadmaps available at AAA, Chicago IL.)
3. Olympic track events are measured in meters or kilometers. Find a listing of Olympic events and make a chart of the length (in metric) of the event and the record time or distance.
4. Some of the records listed in the Guiness Book of World Records are given in metric units. Find some of them and share them with the group.
5. Develop a story activity or other project in which you can relate a continuous set of circumstances using metric measurement (e.g. a trip to the supermarket, a track event, a trip, weather report).
6. Imagine the U.S. was using the metric system today. You turn on your radio and everything is spoken in terms of the metric system. Think of how commercials, weather reports, sports broadcasts, etc. would sound if metric units were used instead of English. Write a 3 to 5 minute radio broadcast. You may tape it on a cassette and present it to the class if you like.
7. Examine the menus from Europe. Take notice of how the measurements of the beverages are listed in metric units. Make a display showing all the different amounts of beverages served, using colored water. You may want to describe your display to the class.

Illustration of Mastery

1. Agreement of "satisfactory" between participant and instructor on the successful completion of at least one of the activities listed above.

LEARNING ACTIVITY 1 EVERYDAY APPLICATION OF METRIC MEASUREMENT (Module 7)

SUPERMARKET ITEMS	ENGLISH UNITS	METRIC UNITS

Objectives

The participant will be able to:

1. convert from metric to English units and vice versa in writing and in actual performance in terms of length, volume, mass in
   - a. estimated outcomes (e.g. longer, larger, smaller).
   - b. accurate conversion in units.

Suggested Activities to Meet Objectives

1. Study chart on "Metric Conversion Factors."
2. Complete Learning Activity #1 on "Using English and Metric Units."
3. Play the game METRIC MAID--length, volume, mass.
4. Play the game METRIC STADIUM BASEBALL.
5. Complete at least two of the following challenge activities:
   - a. Convert a school supplies list to metric units. (Learning Activity #2)
   - b. Convert the daily weather report to metric units (Learning Activity #3).
   - c. Convert punch recipes to metric units (Learning Activity #4).
   - d. Revise a pattern into metric units (Learning Activity #5).
   - e. Prepare a supermarket shopping list in metric units (Learning Activity #6).
   - f. Rescale a baseball diamond and draw the plan in metric units. How far would it be to left field?, right field?, center field?, between bases?, to the pitchers mound?

Illustration of Mastery

1. Completion of posttest with 80 percent accuracy.
2. Agreement of "satisfactory" between participant and instructor on two or more challenge activities.

Sorenson/Kluever

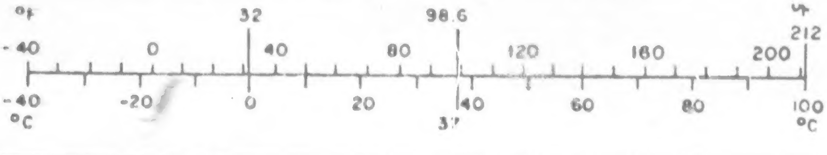
U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS
WASHINGTON, D.C. 20234

NBS Letter Circular 1051
July 1973
(Module 8)

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



6
5
4
3
2
1
inches

---

*1 in = 2.54 cm (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10: 286.

Approximate Conversions from Metric Measures

15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
cm

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

This Letter Circular (LC1051) provides conversion factors for going from the more common customary units to metric units and vice versa. It may be reproduced freely. LC1051 is based on NBS Special Publication 365 (Revised Nov. 1972), "Metric Conversion Card", available by purchase as a wallet-size plasticized card from the U.S. Government Printing Office, Superintendent of Documents, Washington, D.C. 20402. Price 20 cents domestic postpaid, or 10 cents GPO Bookstore. Stock Number 0303–0168. Catalog No. C13.10: 365/2. (25 percent discount on orders of 100 or more copies).

Learning Activity #1 USING ENGLISH AND METRIC UNITS (Module 8)

1. Measure 3 objects in the classroom or IMC. Record the lengths below in metric units. Then, using the conversion factors, record the English units. To check, measure in English and convert to metric.

Item	Metric	English
1.		
2.		
3.		

2. Weigh 3 objects in the classroom or IMC. (They may be the same or different from the objects used in #1) Record the masses (or weights) as you did in #1.

Item	Metric	English
1.		
2.		
3.		

3. Fill an unmarked beaker with some water (any amount). Find out the volume in all metric units listed below. Then convert it to English units listed below, using the conversion factors. Check it by measuring in English. Then take the temperature of the water in both metric and English units.

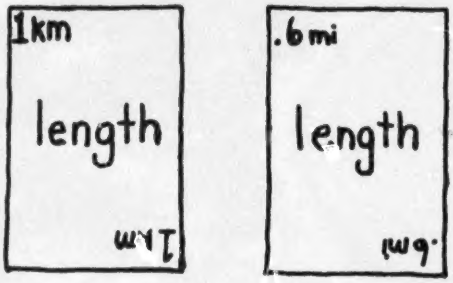
Metric	English
__________ ml	__________ tsp
__________ cl	__________ Tsp
__________ dl	__________ fl oz
__________ l	__________ c
__________ dkl	__________ pt
__________ hl	__________ qt
__________ kl	__________ g

Temperature __________ ° C or __________ ° F

Sorenson/Kluever

GAME METRIC MAID (Module 8)

Materials: Deck of 21 - 45 cards as shown in the example:
All cards must be one of a pair
except for one odd one,
the Metric Maid.



These cards would make a match.

The following values are suggested as pairs:

1 km = .6 mi
1 m = 1.1 yd
1 cm = .4 in
1 mm = .04 in

1 kg = 2.2 lbs
1 g = .035 oz

1 mi = 1.6 km
1 yd = .9 m
1 ft = 30 cm
1 in = 2.5 cm

1 lb = .45 kg
1 oz = 28 g

1 liter = 1.06 qt
1 ml - .03 fl oz

1 gal= 3.8 l
1 qt = .95 l
1 pt = .47 l
1 c = .24 l
1 fl oz = 30 ml
1 Tbs= 15 ml
1 tsp= 5 ml

Players: 2 - 4

Rules:

1. Dealer shuffles and deals all cards.
2. Players sort their cards and place all pairs together. A pair is the 2 cards that name equal measurements in English and metric (e.g., 1 inch and 2.54 cm).
3. The player to the left of the dealer draws a card from the hand of the player to his or her left. The player then places all pairs of cards on the table face up. Other players check to be sure all pairs are correct.
4. The next player to the left draws a card from the player on his or her left and places all pairs on the table.
5. The game continues until all cards except the Metric Maid have been matched and placed on the table. The player having the Metric Maid card is the loser. The player with the most cards on the table may be called the winner.

Melvin/Kluever

Materials: Game Board (see illustration, next page)

Question cards: 4 sets - singles, doubles, triples, homeruns (singles are the easiest questions to answer, doubles a bit harder, and so on; homeruns are the most difficult). Use different color cards for each set to differentiate among singles, doubles, triples, homeruns. Questions may be based just on the metric system or may include metric-English conversions. (See samples on next page).

Extra cards may be inserted in each set, such as: (1) Walk! Go to first base (2) Your fly ball was caught by the center fielder (3) You're OUT!

Golf tees

Players: Two teams with from one to four players on each team (It doesn't matter if there are the same number of players on each team).

Rules:

1. The game is played very much like a real baseball game, except that the game is only four innings long. Each team gets a maximum of 6 turns at bat (6 questions) in an inning.

2. The four piles of cards are placed face down on the playing table. The team members in the field may take turns asking questions, or they may select a "pitcher" who asks questions for the entire inning. The batter may select a question from any of the four piles.

3. After the batter decides which question level to attempt, the pitcher takes the top card from that pile and reads it aloud. If the batter answers correctly, his/her base runner is advanced. For example, if a double is correctly answered, the advance is to second base. If a question is not answered correctly, an "out" is made. The pitcher should then read the correct answer aloud. Each team gets three outs per inning or a maximum of six turns at bat.

4. Cards with questions that have been asked should be set aside. If any of the piles run out, these cards are shuffled and reused.

5 Each base runner advances the same number of bases as does a successful batter. For example, if there is a runner on second base, and the batter hits a single, the runner on second base may advance only one base. If the batter hits a double, the runner on second base can advance two bases to score a "run."

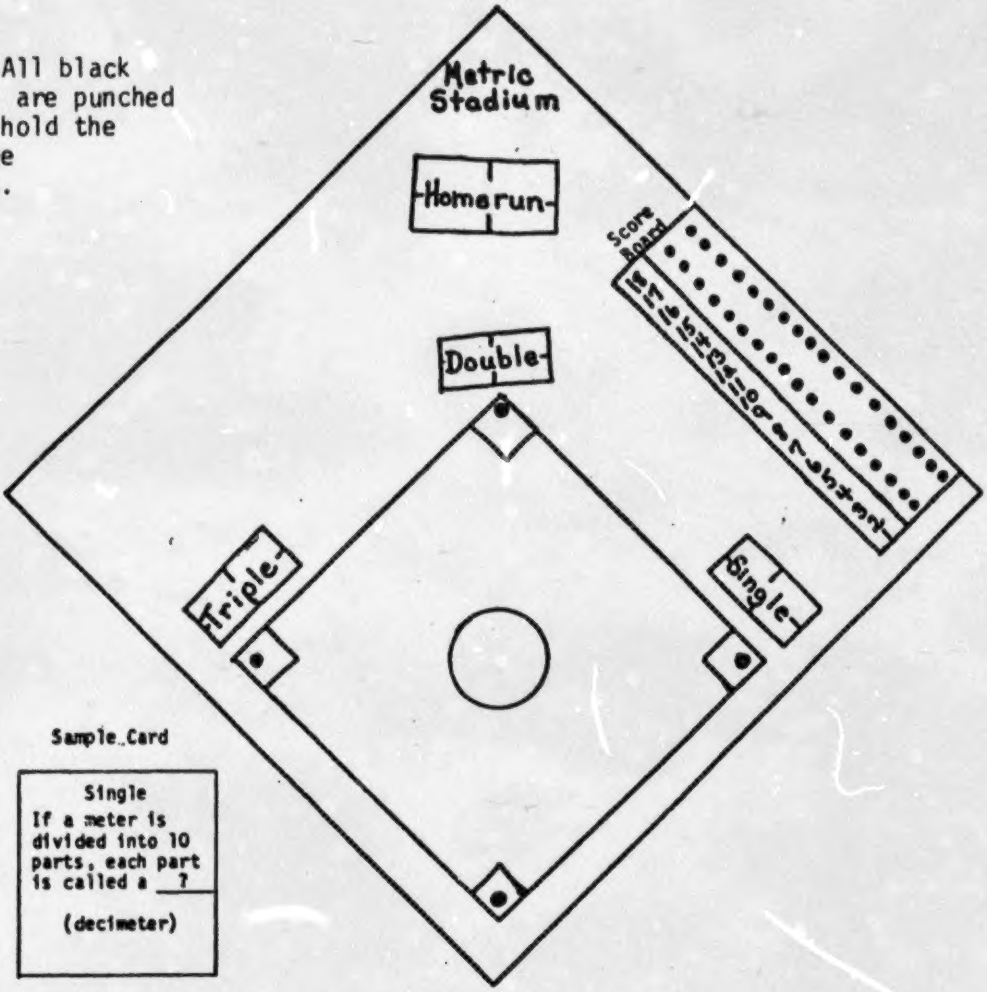
6. Each team can bat only 6 times per inning. If a team has batted 6 times and still hasn't made three outs, it must take the field, allowing the other team a chance to bat. But any runners left on base may return to their respective bases when their team is at bat again. If a team makes three outs, however, runners left on base cannot return to their bases the next inning.

7. Each team keeps score on the score board, and the team that is ahead at the end of four innings wins the game.

Balko

BOARD AND CARD ILLUSTRATIONS

Note: All black circles are punched out to hold the golf tee markers.



Sample Card

Single

If a meter is divided into 10 parts, each part is called a ___?___

(decimeter)

Sample Questions:

Single: 1. How many decimeters are there in a meter?
2. 1,000 meters is called a kilometer; 1,000 grams is called a ___?___

Double: 1. What metric unit of area is about the same as a square yard?
2. At what temperature on the Celsius scale would water boil?

Triple: 1. If a bat is 36 inches long, about how long is it in meters?
2. Your team has a water bucket that holds 12 quarts. About how many liters is that?

Homerun: 1. Which bat would be lighter - one that weighs 4 pounds or one that weighs 12 kilograms?
2. Your team is going to travel 10 kilometers to a neighboring town to play ball. How many miles will you travel?

Below is a request for school supplies. The sizes are given in English measuring units. Convert the sizes to metric units and write them in the appropriate column.

(Prepare 2 Copies)

CENTRAL STORES SUPPLIES
REQUISITION

Department Elementary Education

DATE February 13,1975

Account Code Number 102-055

Requested by J. Sorenson

Building and Room Library 1110

Approved by Max Poole

Stock No.	Quantity Requested	Unit	Item Description	English Measure	Metric Measure	
32298	2	ream	Paper, bond, white	8½X11"		
32444	1	roll	Tape, magic mending	3" core		
32427	1	roll	Tape, masking	½" core		
32218	2	bottle	Glue, Elmer's	16 oz.		
32069	1	pkg-100	Cards, Index	3X5"		
32076	5	box	Cement,rubber	4 oz.		
32073	2	pkg-100	Cards, Index	5X8"		
32012	1	box	Bands, rubber	¼ lb.		
32405	1	each	Scissor	8"		
32404	1	each	Ruler	15"		
32146	1	each	Envelopes, brown	9X12"		
32161	3	Box-100	Fasteners, paper	1 ¼"		
32162	2	Box-100	Fasteners, paper	2 "		
32120	1	can	Duplicating fluid	1 Gal.		

Received by Central Stores Supplies **Date** February 14,1975

Filled by **Number** **Posted by**

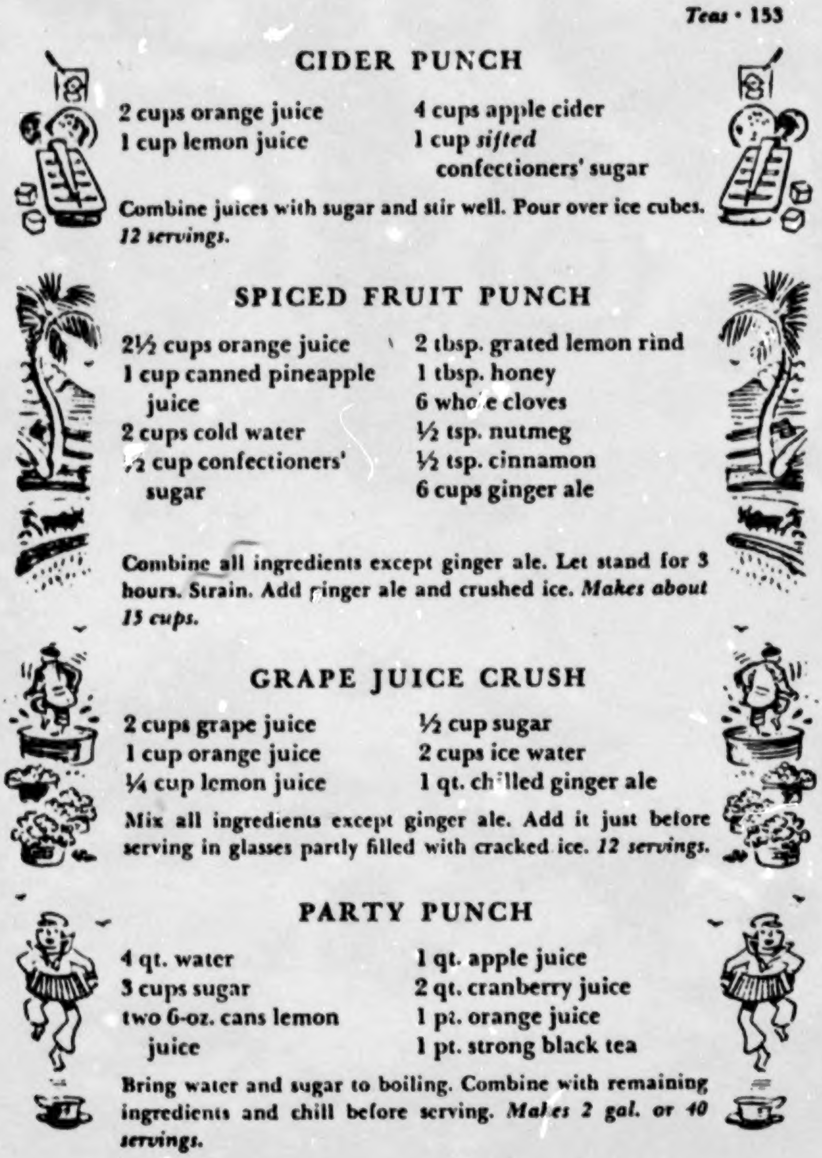
Manthey

Learning Activity #3 METRIC-ENGLISH RELATIONSHIPS (Module 8)

The weather information for a day in March is given below. Convert the information into metric units. You may then rewrite the information in paragraph form suitable for reading on the evening news.

English Units	Temperature	Metric Units
44°F	Current	
49°F	High for the day	
38°F	Low for the day	
-21°F	Coldest temperature in the nation	
87°F	Warmest temperature in the nation	
35°F	Predicted low for tonight	
40°F	Predicted high for tomorrow	
10 mph	Wind Velocity	
29.74 inches	Barometric Pressure	
.03 inches	Precipitation	
3 miles	Visibility	
2,000 feet	Ceiling	

Choose one of the punch recipes given below. Convert the quantities to metric units. Rewrite your recipe in the space to the right.



Teas · 153

CIDER PUNCH

- 2 cups orange juice
- 1 cup lemon juice
- 4 cups apple cider
- 1 cup *sifted* confectioners' sugar

Combine juices with sugar and stir well. Pour over ice cubes. *12 servings.*

SPICED FRUIT PUNCH

- 2½ cups orange juice
- 1 cup canned pineapple juice
- 2 cups cold water
- ½ cup confectioners' sugar
- 2 tbsp. grated lemon rind
- 1 tbsp. honey
- 6 whole cloves
- ½ tsp. nutmeg
- ½ tsp. cinnamon
- 6 cups ginger ale

Combine all ingredients except ginger ale. Let stand for 3 hours. Strain. Add ginger ale and crushed ice. *Makes about 15 cups.*

GRAPE JUICE CRUSH

- 2 cups grape juice
- 1 cup orange juice
- ¼ cup lemon juice
- ½ cup sugar
- 2 cups ice water
- 1 qt. chilled ginger ale

Mix all ingredients except ginger ale. Add it just before serving in glasses partly filled with cracked ice. *12 servings.*

PARTY PUNCH

- 4 qt. water
- 3 cups sugar
- two 6-oz. cans lemon juice
- 1 qt. apple juice
- 2 qt. cranberry juice
- 1 pt. orange juice
- 1 pt. strong black tea

Bring water and sugar to boiling. Combine with remaining ingredients and chill before serving. *Makes 2 gal. or 40 servings.*

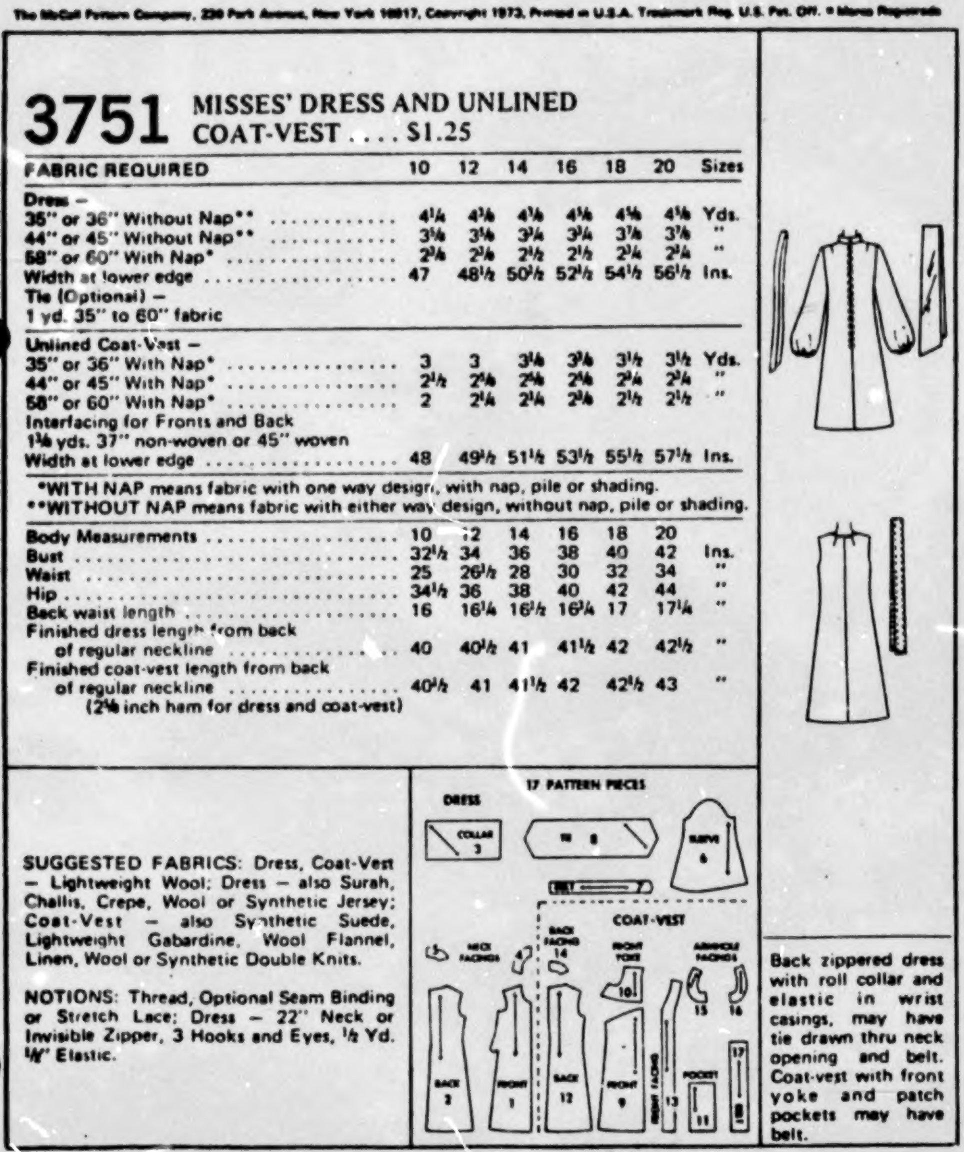
Betty Crocker's Guide to Easy Entertaining. New York: Golden Press, 1959.

Melvin

Learning Activity #5 METRIC-ENGLISH RELATIONSHIPS (Module 8)

On this page you are given the information from the back of a pattern envelope. Choose the size you wish to convert.

1. Find the Body Measurements section. Convert these measurements (for one size) to metric measurements.
2. Using either the dress or the coat-vest, convert (to metric) the fabric widths and the amount of fabric required for each width.
3. Convert the zipper and elastic measurements to metric.



The McCall Pattern Company, 230 Park Avenue, New York 10017, Copyright 1973, Printed in U.S.A. Trademark Reg. U.S. Pat. Off. [illegible]

3751 MISSES' DRESS AND UNLINED COAT-VEST $1.25

FABRIC REQUIRED	10	12	14	16	18	20	Sizes
Dress –							
35" or 36" Without Nap**	4¼	4⅜	4⅛	4⅛	4⅝	4⅝	Yds.
44" or 45" Without Nap**	3⅛	3⅛	3¾	3¾	3⅞	3⅞	"
58" or 60" With Nap*	2¾	2⅜	2½	2½	2¾	2¾	"
Width at lower edge	47	48½	50½	52½	54½	56½	Ins.
Tie (Optional) – 1 yd. 35" to 60" fabric							
Unlined Coat-Vest –							
35" or 36" With Nap*	3	3	3⅛	3⅜	3½	3½	Yds.
44" or 45" With Nap*	2½	2⅝	2⅝	2⅝	2¾	2¾	"
58" or 60" With Nap*	2	2¼	2¼	2⅜	2½	2½	"
Interfacing for Fronts and Back 1⅜ yds. 37" non-woven or 45" woven							
Width at lower edge	48	49½	51½	53½	55½	57½	Ins.

*WITH NAP means fabric with one way design, with nap, pile or shading.
**WITHOUT NAP means fabric with either way design, without nap, pile or shading.

Body Measurements	10	12	14	16	18	20	
Bust	32½	34	36	38	40	42	Ins.
Waist	25	26½	28	30	32	34	"
Hip	34½	36	38	40	42	44	"
Back waist length	16	16¼	16½	16¾	17	17¼	"
Finished dress length from back of regular neckline	40	40½	41	41½	42	42½	"
Finished coat-vest length from back of regular neckline	40½	41	41½	42	42½	43	"

(2⅝ inch hem for dress and coat-vest)

SUGGESTED FABRICS: Dress, Coat-Vest – Lightweight Wool; Dress – also Surah, Challis, Crepe, Wool or Synthetic Jersey; Coat-Vest – also Synthetic Suede, Lightweight Gabardine, Wool Flannel, Linen, Wool or Synthetic Double Knits.

NOTIONS: Thread, Optional Seam Binding or Stretch Lace; Dress – 22" Neck or Invisible Zipper, 3 Hooks and Eyes, ½ Yd. ¼" Elastic.

Back zippered dress with roll collar and elastic in wrist casings, may have tie drawn thru neck opening and belt. Coat-vest with front yoke and patch pockets may have belt.

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Size ____________

Body Measurements

Bust ____________

Waist ____________

Hip ____________

Waist Length ________

Dress Length ________

Coat-Vest Length ____

Fabric Widths

35" ____________

44" ____________

58" ____________

Fabric Required

for ____________

Metric Width	Metric Length
________	________
________	________
________	________

Tie ____________

Interfacing ________

Learning Activity #6 METRIC - ENGLISH RELATIONSHIPS (Module 8)

Listed below is a shopping list for tomorrow's trip to the supermarket. The quantities are given in English units. Convert the quantities into metric units. Record the total quantity in metric units in the column on the right.

	Total Quantity (metric units)
(2) 1 lb. loaves of bread	
1 lb. box of crackers	
3½ lb. roast	
12 oz. bacon	
10 oz. cheddar cheese	
24 oz. cottage cheese	
3 oz. parmesan cheese	
8 oz. sweet pickles	
2 qts. apple juice	
1 gal. milk	
1 stick butter	
1 extra large box of detergent (5 lb. 4 oz.)	

Melvin

CONVERTING ENGLISH AND METRIC UNITS - POSTTEST (Module 8)

1. __________ If a 12" ruler was marked in centimeters, it would contain:

   a) 24 centimeters
   b) 30 centimeters
   c) 36 centimeters

2. __________ In metric, a 14" pizza would measure:

   a) 28 centimeters
   b) 35 centimeters
   c) 40 centimeters

3. __________ If football fields were measured in meters instead of yards, the length would be:

   a) 100 meters
   b) 90 meters
   c) 75 meters

4. __________ A trip from Chicago, Illinois to New York City would be 840 miles or:

   a) 504 kilometers
   b) 1176 kilometers
   c) 1344 kilometers

5. __________ One centimeter equals:

   a) .7 inches
   b) .4 inches
   c) 2.5 inches

6. __________ One teaspoon equals

   a) 5 milliliters
   b) 15 milliliters
   c) 10 centiliters

7. __________ A recipe calls for 2 tablespoons of milk. In metric units that would be:

   a) 3 centiliters
   b) 15 milliliters
   c) 10 milliliters

8. __________ If you ordered a 25 centiliter glass of pop, you would have about:

   a) one cup
   b) one pint
   c) one quart

9. ________ A Payday candy bar would weigh about:

a) 35 grams
b) 35 ounces
c) 350 grams

10. ________ A 12 ounce package of sandwich meat would weigh about:

a) 120 grams
b) 240 grams
c) 336 grams

11. ________ One quart equals:

a) 1.06 liters
b) .95 liters
c) 95 milliliters

12. ________ A pint of cream would contain:

a) 47 centiliters
b) .24 liters
c) 47 milliliters

13. ________ A man weighing 250 pounds could also say he weighed:

a) 400 kilograms
b) 112.5 grams
c) 112.5 kilograms

14. ________ A gram equals:

a) .35 ounces
b) .035 ounces
c) 28 ounces

15. ________ Which is larger:

a) 500 kilograms
b) 1050 pounds
c) .105 metric tons

16. ________ The only exact measurement, when comparing English and metric units, is:

a) 1 quart = .95 liters
b) 1 inch = 2.54 centimeters
c) 1 kilogram = 2.2 pounds

17. ________ If a Celsius thermometer gave a reading of 25^{0}, it would be about the same as:

a) 27^{0} F
b) 77^{0} F
c) 45^{0} F

18. __________ If a Fahrenheit thermometer read -5°, it would be about the same as:

    a) 20° C
    b) 9° C
    c) -20° C

19. __________ Water freezes at:

    a) 0° F
    b) 0° C
    c) 32° C

20. __________ A gallon of milk would be:

    a) larger than 4 liters.
    b) smaller than 4 liters.
    c) the same as 4 liters.

Objectives

The participant will be able, alone or with others, to:

1. develop a plan for teaching metric measurement at the age/grade level at which he/she teaches. The plan will include provision for:
    a. metric content
    b. objectives for the students
    c. assessments (pre and post)
    d. a variety of grouping patterns
    e. a variety of activities and materials

Suggested Activities to Meet Objectives

1. Review modules used to present metric measurement to teachers.
2. Review ideas, activities, materials on display at the workshop and in your local building and/or system and the city media centers.
3. Develop a plan for implementation that includes: (a) objectives "a through e" in objective 1 above: (b) a timeline for implementation and evaluation: (c) an indication of how your plan relates to metric instruction of children at lower and higher age/grade levels than yours; and (d) evaluation and modification of the plan.

    Note: This plan is to be presented in two stages:

    (1) in outline form before starting the project.

    (2) in detailed form (ready to teach from and may include instructional materials) at completion of course.

Illustration of Mastery

The participant will exhibit mastery by:

1. agreement of "satisfactory" between participant and instructor on:
    a. outline of the plan.
    b. detailed plan (may include instructional materials).

Sorenson

All You Will Need to Know About Metric

(For Your Everyday Life)

10

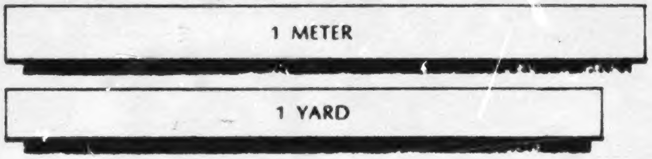
Metric is based on Decimal system

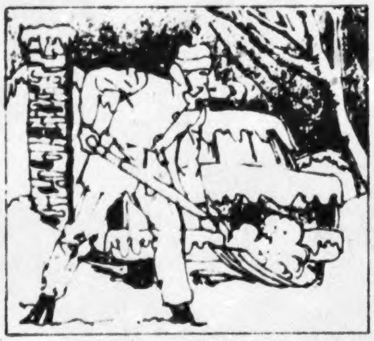
The metric system is simple to learn. For use in your everyday life you will need to know only ten units. You will also need to get used to a few new temperatures. Of course, there are other units which most persons will not need to learn. There are even some metric units with which you are already familiar: those for time and electricity are the same as you use now.

BASIC UNITS

METER: a little longer than a yard (about 1.1 yards)
LITER: a little larger than a quart (about 1.06 quarts)
GRAM: about the weight of a paper clip

(comparative sizes are shown)



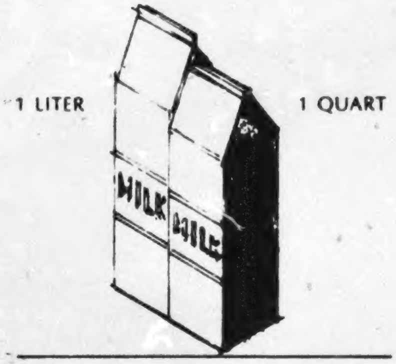


25 DEGREES FAHRENHEIT

COMMON PREFIXES
(to be used with basic units)

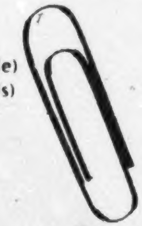
Milli: one-thousandth (0.001)
Centi: one-hundredth (0.01)
Kilo: one-thousand times (1000)

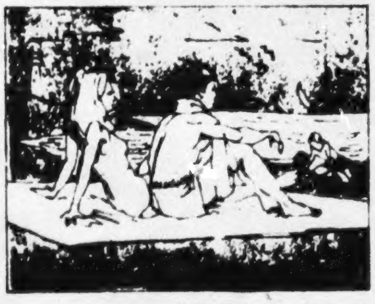
For example:
1000 millimeters = 1 meter
100 centimeters = 1 meter
1000 meters = 1 kilometer



OTHER COMMONLY USED UNITS

Millimeter:	0.001 meter	diameter of paper clip wire
Centimeter:	0.01 meter	width of a paper clip (about 0.4 inch)
Kilometer:	1000 meters	somewhat further than ½ mile (about 0.6 mile)
Kilogram:	1000 grams	a little more than 2 pounds (about 2.2 pounds)
Milliliter:	0.001 liter	five of them make a teaspoon

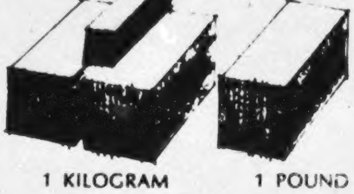




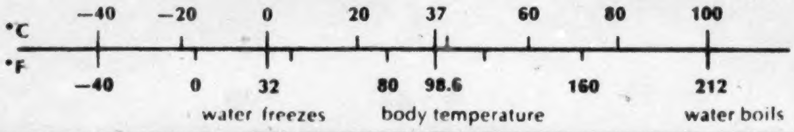
25 DEGREES CELSIUS

OTHER USEFUL UNITS

Hectare: about 2½ acres
Tonne: about one ton



TEMPERATURE
degrees Celsius are used



For more information, write to: Metric Information Office, National Bureau of Standards
Washington, D.C. 20234

DEPARTMENT OF COMMERCE · UNITED STATES OF AMERICA

ANSWER KEYS FOR TESTS AND WORKSHEETS

MODULE 1

Posttest

1. meter
2. France
3. U. S.
4. liter
5. gram/kg
6. larger
7. smaller
8. metric
9. lighter
10. standard

MODULE 2

"Kite Tails"

1. 4 cm
2. 40 mm
3. 17 cm
4. 50 mm
5. 7.5 cm
6. 3 cm
7. 20 mm
8. 25 mm
9. 1 dm
10. 7 cm

MODULE 2

Pretest

1. e
2. d
3. d
4. b
5. c
6. b
7. d

8a cm
  b mm
  c hm
  d km
  e dm
9a 1000
  b 100
  c 10
  d .1
  e .01
  f .001

MODULE 2

Pretest (cont)

10a less than
  b greater than
  c greater than
  d less than
  e less than
11a centimeter
  b meter
  c kilometer
  d millimeter
  e meter

MODULE 2

Posttest

1. c
2. b
3. d
4. c
5. e
6. d
7. d
8. d
9. b
10. a

11a 3 cm
  b 1/5 km
  c 18 cm
  d 240 km
12. variable
13a 6 cm
  b 4 cm
14a 40 mm
  b 20 mm
15. 5 km

MODULE 3

Posttest

1. liter
2. smaller
3. 1000
4. centiliters
5. dekaliter
6. liters
7. 1000
8. 10
9. e
10. a
11. j
12. i
13. h
14. g
15. c

MODULE 4

Posttest

1. gram
2. larger
3. grams
4. hectogram
5. centigrams
6. kilogram
7. 1000
8. decigrams
9. g
10. e
11. h
12. a
13. j
14. b
15. c

MODULE 5

"What's Temp?"

1. 37 C
2. -10
3. 30 C
4. 20 C
5. 0 C
6. 100 C

MODULE 5

Posttest

1. a
2. c
3. a
4. b
5. a
6. a
7. b
8. a
9. c
10. b

MODULE 6

"Time-Breakfast"

1. c
2. a
3. a
4. c
5. b
6. c
7. b
8. b
9. a
10. c

MODULE 6

Posttest

1. c
2. g
3. k
4. b
5. j
6. h
7. e
8. a
9. i
10. d
11. 1 liter
12. 1 gram
13. dm^3
14. 1 liter
15. cm^3

MODULE 8

Posttest

1. b
2. b
3. b
4. c
5. b
6. a
7. a
8. a
9. a
10. c
11. b
12. a
13. c
14. b
15. a
16. b
17. b
18. c
19. b
20. b

CROSSWORD PUZZLE ANSWER KEYS

LENGTH

Across:
1. deka
4. millimeter
6. decimeter
8. hundred
9. cm
10. dekameter
11. meterstick
13. shorter
15. length
16. km
17. thousand
18. centi
19. longer
20. deci

Down:
1. dkm
2. yard
3. meter
5. mm
7. centimeter
8. hecto
12. kilometer
14. hectometer

VOLUME

Across:
2. milliliter
3. dekaliter
4. dl
5. kl
7. centiliter
9. hl
10. hectoliter
13. volume
15. ml
16. smaller

Down:
1. quart
2. metric
3. dkl
4. deciliter
5. kiloliter
6. deci
8. centi
11. cl
12. larger
14. liters
15. milli

MASS

Across:
1. smaller
3. hg
5. centi
8. dkg
10. deka
11. kg
13. larger
14. centigram
16. deci
18. meter
21. kilo
22. dekagram
23. cg
24. mass

Down:
2. milligram
3. hectogram
4. liter
6. paperclip
7. mg
9. kilogram
12. dg
15. hecto
17. gram
19. milli
20. decigram

CONVERSIONS

Across:
2. mass
3. volume
4. ml
8. liter
9. l
10. length
11. meter
13. centimeter
14. gram
16. m
17. cm

Down:
1. degree celsius
2. millimeter
5. liter
6. gram
7. kg
9. liter
12. kilogram
15. mm

MEASUREMENT PUZZLES - ANSWER KEYS

LENGTH

57 km .01 m 4 m 23 dkm	.023 hm 40 dm .1 cm 5.7 hm	2.3 dm 1 mm 4 mm 57 m	.057 mm .4 cm .01 mm .023 km
230 m 400 km 40 hm 57 dm	570 m 4 km 10 m 2.3 cm	570 dm 1 dkm 40 mm 230 hm	23 m 4 cm 10 dm 57 cm
5.7 m .01 mm 400 dm 57 mm	23 mm 40 m 400 m 5.7 km	23 km 40 dkm 1 dm 2300 mm	570 mm 10 cm .4 mm 230 dkm
5.7 cm 1 mm 40 km 230 km	57 hm 400 hm 10 dkm .057 cm	230 cm .1 km 4 dm 23 cm	23 hm .04 dkm .04 mm 570 km

VOLUME

370 ml 6 l 2000 l 1 m^3	4.2 l 2 m^3 2 l 560 l	37 ml 2000 ml .34 l 1 l	.42 ml 340 ml 7 l 56 cm^3
1000dm^3 .7 ml 3400 l .56 l	.56 m^3 3.4 m^3 .034 l 1 ml	1 dm^3 34 cm^3 2 cm^3 5.6 l	56 ml 2 ml 60 ml .002 l
560 ml 60 l 1000 l 2 dm^3	1 cm^3 1 m^3 34 l 2000 l	5600 ml 34000 ml 3.4 l .056 l	2 cm^3 3400 cm^3 7 ml .0056 l
2000 cm^3 70 ml .001 l 3.7 l	2 m^3 1 cm^3 1 l 42 cm^3	56 ml 1000 ml 3.4 cm^3 37 l	5.6 ml 3.4 ml .6 ml 42 l

MASS

.1 mg .069 mg 10 g 69 cg	.0012 kg 100 dg 300 g 69 mg	1.2 dg .3 kg 1 dg .69 kg	.02 mg 10 cg 690 kg 1200 g
690 mg .01 mg 3 dg 69 g	6.9 cg .3 g .1 cg 1200 mg	690 g 1 mg 300 dg 1.2 cg	1.2 kg 30 g 300 kg 69 dg
690 dg 10 dg 3 mg .012 kg	120 cg .3 cg .003 t .12 kg	12 mg 3 kg 100 g 6.9 kg	6.9 g .1 kg .069 cg .012 t
12 g 69 kg 30 mg 120 kg	120 g 3 cg 3 g .3 mg	6900 g 30 dg 30 kg 12 cg	12 kg .03 t .01 g .03 mg

References

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11. U. S. Government. Letter Circular (LC1051). Metric Conversion Factors. U. S. Government Printing Office, Superintendent of Documents. Washington, D. C. 20402. Price: $.20.
12. Williams, Hazel. "Mix-A-Meter". Teacher, Volume 91, Number 6, 1974.

Some Sources of Metric Materials for Elementary Schools

Activity Resources Co., Inc.
P. O. Box 4875
Hayward, Calif. 94545
(print and equipment)

Copp Clark Publishing
517 Wellington St. W.
Toronto, Canada
Book: How to Think Metric,
by W. W. Bates &
O. Fullerton

Denoyer-Geppert
5235 Ravenswood Ave.
Chicago, Ill. 60640
312/561-9200
(A-V materials; equipment)

Dick Blick
P. O. Box 1267
Galesburg, Ill. 61401
(METRIC-AIDS, equipment)

Educational Teaching Aids
159 W. Kinzie St.
Chicago, Ill. 60610
312/644-9438
(equipment, kits)

Houghton Mifflin
1900 South Batavia Ave.
Geneva, Ill. 60134
(print and equipment)

Idaho Research Foundation, Inc.
University Station Box 3367
Moscow, Idaho 83843
Book: Handbook for Metric
Conversion, by D. Johnson
and B. VanOsdol

The Learning Tree
P. O. Box A
New Lisbon, WI 53950
(kits)

Math Shop, Inc.
5 Bridge St.
Watertown, MA 02172
(equipment)

Charles E. Merrill Publishing Co.
1300 Alum Creek Dr.
Columbus, Ohio 43216
(METRIKIT)

Mind/Matter Corp.
P. O. Box 345
Danbury, CT 06810
(equipment, kit)

Penton Publishing Co.
Penton Plaza
Cleveland, Ohio 44114
Book: Metrication

Ronningen Metric Co.
6102 Palo Cristi
Paradise Valley, AZ 85253
Pamphlet: Weights and Measures -
U.S. to Metric - Metric to U.S.

Selective Educational Equipment (SEE), Inc
3 Bridge St.
Newton, MA 02195
(equipment)

SVE (Society for Visual Education)
1345 Diversey Parkway
Chicago, Ill. 60614
(BEGINNING METRIC MEASUREMENT - LEARNING
MODULE - kit)

Swani Publishing Division
P. O. Box 248
Roscoe, Ill. 61073
(books, pamphlets, kits, A-V aids)

TWS Electronics, Inc.
P. O. Box 113
So. Beloit, Ill. 61080
815/389-4555
(electronic calculator & METRIC
CONVERTER - various models)

John Wiley & Sons, Inc.
P. O. Box 4192
Grand Central Station
New York, N. Y. 10017
Book: Thinking Metric
by T.F. and M.B. Gilbert

Appendix A

METRIC IDEAS FOR ELEMENTARY STUDENTS

All of the activities here have been used successfully with elementary students. Activities may be used at learning stations, with small groups of students or in some cases the student may carry out the activity alone. It should be noted that students should have mastered a basic skill in the general area of measurement before attempting a metric activity that requires that skill. Items which are starred (*) indicate variations or extensions of an activity.

Activities have been classified as "primary" and "intermediate" levels to help teachers select those most appropriate for their students. However, if students are studying metric measurement for the first time, intermediate level students will find "primary" activities exciting, too.

METRIC MATCH (Primary, general)

1. Draw "metric match" board as illustrated in the picture. Place metal fasterners on the dots.
2. Attach strings of equal length to each metal fastener in the right hand column. Be sure the strings are long enough to reach all matching pairs.
3. Have students match prefix with number by connecting strings.
4. Provide an answer key on the reverse side of the card.

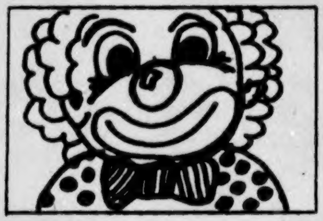
METRIC MATCH	
milli ●	● 1/10
deci ●	● 1/100
kilo ●	● 1000
hecto ●	● 1/1000
centi ●	● 1/100
deka ●	● 10

METRIC PICTURE PUZZLES (Primary, general)

1. Draw a picture on a piece of tagboard and cut it into nine equal pieces.
2. Draw lines on another piece of tagboard, exactly the same size as the first.
3. Put puzzle pieces on top of the whole board and write matching prefix and numbers on back of puzzle piece and corresponding section of tagboard.
4. Students should match the prefix or number on the back of each puzzle piece to the matching word or prefix on puzzle board.
5. If the pieces form a picture when the student is finished, the child has correctly matched the prefixes with the numbers.

hecto	milli	1000
100	1/10	kilo
1/100	deka	10

Puzzle Board



(Front)

100	$\frac{1}{1000}$	kilo
hecto	deci	1000
centi	10	deka

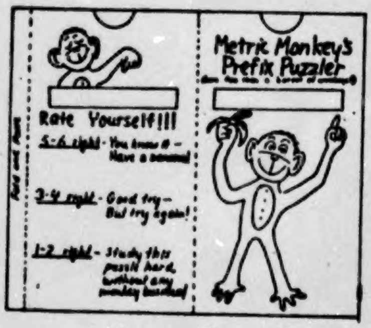
(Back)

Puzzle Answer Sheet

METRIC MONKEY'S PREFIX PUZZLER

(Primary, Intermediate, General)

1. Construct the puzzler as follows:
   a. Make the outside by enlarging the diagram below on colored paper (construction or lightweight card stock).
   b. Make the inside as illustrated below so it can be inserted in the outside folder.
   c. Put the inside in place in the folder and paste the puzzler together.
2. Give a puzzler to each child and have him or her quiz him or herself or others.


Metrik Monkey's
Prefix Puzzler
Rate Yourself!!!
5-6 right
3-4 right - Good try —
But try again!
1-2 right - Study this
puzzle hard,
without any
monkey business!

Outside Folder

deci	1/10
centi	1/100
hecto	100
deka	10
kilo	1000
milli	1/1000

Fold

Inside

LICORICE LENGTH

(Primary, length)

1. Give each student a long (30-50 centimeters) strand of string licorice and have him or her measure it.
2. Have students estimate varying lengths by directing them to eat so much licorice, for example: "Eat one decimeter of licorice."
3. Students can then check their estimates by measuring the remaining piece and subtracting that number from the length of the original piece.
4. Have students keep a continuing record from original length through each subtraction.

METRIC GRADUATION HAT (Primary, Length)

1. As a culminating activity on the metric system, have the students make their own graduation hats.

2. Give each student 2 pieces of construction paper and have them measure and cut a square 3 dm x 3 dm.
3. Hand out tape measures to each student and tell them to measure their heads and then cut a strip of construction paper the circumference of head by 6 cm wide. Tape end of strip together to form the base of the hat.
4. Construct hat by attaching 3 dm x 3 dm square piece to base of hat strip.
5. Measure yarn for tassles and attach to hat.

"GRAM" CRACKERS (Upper Primary, Intermediate, Mass and Area)

1. Give each student a "gram" (graham) cracker and have him or her weigh it. Provide a sheet to record the answer.
2. Have the student take a small bite and weigh the cracker again. Record answer.
3. As a last activity before eating the entire cracker, have the student take a big bite, weigh the remaining cracker and record the answer.

*4. Have students find the area of the cracker before and after taking bites.

* Use centimeter grid paper to estimate area.

METRIC MARKET (Primary, All Metric Units)

1. Have each of the students look at home for packaged foods that are labeled with metric units, along with the English units or alone.
2. When the packages are empty have the students bring them to school. Construct a store out of a refrigerator box to display all of the items. Have the children make up a name for the store such as "DEKA DISCOUNT".
3. Give each child a chance to be the clerk in the store.

METRIC ROPE

(Primary, Intermediate, Length)

1. Make a yarn measuring rope by cutting pieces of very heavy yarn or cord of two colors in lengths so each will measure one meter when tied to another piece of the same length. Tie lengths, alternating colors, to make a 10 meter rope (longer if desired).
2. Use the rope to measure distances such as the length of the playground, a city block, or the distances between bases on a baseball diamond. Record five distances that you measure and have someone else check the distance to see if the measurements agree.
3. If you are measuring very long distances, several children with several ropes could work together.

DECIMETER DETECTIVES

(Intermediate, Length)

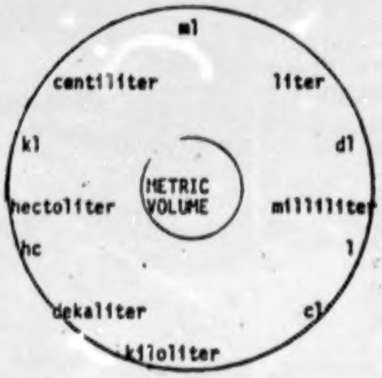
1. Give each student a set of cuisenaire rods.
2. Tape the following instructions on a cassette:

> Pretend you are a detective in metric land. Your mission, if you choose to accept it, will be to discover the various combinations that are needed to make a decimeter. We would like to warn you, however, that you might not need all wooden rods. If you fail in this task you will be banned from the metric detective force. This tape will self destruct in thirty seconds.

METRIC VOLUME PIZZA

(Intermediate, Volume)

1. Make a metric volume pizza game by covering and laminating a 6-inch pizza or other round board.
2. Write metric symbols and names on the board (see picture). Write the reverse symbols or letters on clothespins and match by clipping the clothespin to the word or vice versa.
3. Put the correct answer (e.g., the clothespin for the symbol, ml, is marked milliliter) on the reverse side of the board for self-checking.



POSTAL PROBLEMS (Intermediate, Mass)

1. Stuff 8 to 10 envelopes with different amounts of paper.
2. Obtain a postal or diet gram scale.
3. Develop a chart showing postal rates or obtain one from the post office. For instance, a 25 gram letter would require a thirteen cent stamp, etc.
4. Have the children determine the postal rate for each letter by weighing it.

TRAFFIC COPTER REPORT (Intermediate, All Metric Units)

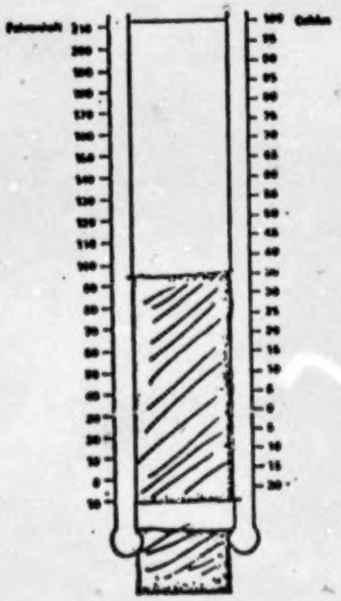
1. Give the students the following instructions:

   > Pretend you are reporting traffic conditions from a helicopter over a large city. Report for two to three minutes using metric units whenever measuring units for length, mass, volume and temperature are appropriate. Tape the report and play it for others. Have them determine how many times a metric unit was used.

2. Suggest to the students that they write a script before attempting to record.

TEMPERATURE SLIDE (Intermediate, Temperature)

1. Make the temperature slider (as illustrated) by printing the Celsius and Fahrenheit scales side by side on a strip of tagboard. Leave a two-inch space in between the two thermometers and cut two slits across the top and bottom of this space. Insert another strip of tagboard through these slits. The strip to be inserted should be 2 inches wide and half black and half white.
2. Have the students push their sliders on the thermometer to certain degrees on either scale to find out the equivalent on the other scale. For instance, you could say "Push the slider on the thermometer to 90 degrees Fahrenheit. What is the equivalent temperature on the Celsius scale?"



METRIC MUNCH (Intermediate, Area)

1. Bring a cake pan of brownies, rice krispies bars, or any other goody to class.
2. Have one child measure the area of the pan in centimeters and have the rest of the class estimate the area of the pan. Compare the estimates with the actual measurement.
3. Have the children determine the area of each piece if they were to divide the pan equally among the entire class.
4. Cut the pan according to the direction of the students and give each a piece.

LINEAR LEAF (Intermediate, Area)

1. Trace around the edge of various sized leaves and objects. Match a string to the perimeter of the shape and determine the perimeter of the leaf in centimeters by measuring the string.
2. Trace around several leaves on centimeter grid paper and determine the area in square centimeters.
3. Estimate the area of the leaf in square centimeters using the cm^2 grid.

SWEET TOOTH (Intermediate, Area)

1. Bring sweet objects from home such as doughnuts, cookies and candy bars.
2. Estimate the area of the object.
3. Using the centimeter graph paper (p. 87), place the sweet object on the grid paper and find the area of the object by counting the squares.

Variations: Eat a proportion of the sweet object and find the new area.